Chapter 1

Artificial Intelligence Tools and Case Base Reasoning Approach for Improvement Business Process Performance

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Additional information is available at the end of the chapter

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1. Introduction

Contemporary and every day more perfect information achievement, becomes available for everybody, and simply, very quickly become a necessity. It is necessary that organizations use information technology as a tool for developing a sense of learning, acquire and use knowledge. Information tools should not be use like tools for automation of existing processes. There should be another aspect or already obsolete category. With this aspects, thinking and attitudes, it can be said that we living in the century of knowledge and that we have already overcome period of information technology which should be, simply, implemented like support in the way for achieving knowledge.

This informational environment has been recognized in the world and because of there are significant rising in the use of artificial intelligence tools. There is evidence that is a great number of eligible to use and easily available software for needs of the development of such as systems in the field of artificial intelligence. Also, in [1] states that investment and implementation of artificial intelligence show significant results, particularly in attempt of to get higher profit. The artificial intelligence, like the word itself says is the area that deals with the development of systems that mimic human intelligence and a man with tend to replace him in some activities based on knowledge. That is way for over viewing problem of human absence, cost of services, disinclination of people to provide knowledge and similar. Specified conditions, particularly from the standpoint of the necessities of knowledge, and also the fact that in area of research topic for the purposes of quality management systems, there are evident gap [2, 3-10, 11]. That facts justifying the author's striving to be in this research and accept to use artificial intelligence tools for developing systems oriented to knowledge. These views and attitudes were in agreement: that there is no correct programming software that has a strong base of knowledge that could assist in identification of a problem, that has not developed a single expert system that deals with the measurement, evaluation, corrective and preventive action to improve organizational performance and the like [12, 13-16, 10]. It is also an incentive to be based on such analogies create a foundation set up and entered the field of artificial intelligence in order to obtain knowledge as one of the most important factors for creating competitiveness in the market [17-19, 20].

Everything above can be understand like introduction for developing an research whit main aim for developing a system in the field of artificial intelligence that would be based on the analysis in the quality management system and that has given recommendations for achieving business excellence and improve the financial performance of the organization. The main parts and activities of that research stay in the basis of this chapter.

2. The main targets, methods and contribution

Based on the introduction and results of researching literature source and practice, in the scope of this research, it can be set up main targets, and that are:

- to find (regardless of size or type of organization) area in organization which have priority from the standpoint of improvement,
- to establish new concept of Degree of Readiness and Coefficient of Significance which can show intensity and type of action which should be provide in direction of achieving business excellence and
- to develop and testing in real condition an expert system for improvement business process performances even those of financial character base on analogy with human body function.

In this sense, it can be use science method for inductive and deductive way of deciding and concluding. First one was used for collecting, estimating and analyzing of experimental data, or to making general knowledge by using specific knowledge and particular facts. The second one was used for applying and checking specific conclusion in real condition.

Also, like science approaches it was used: analogy method, expert decision and "ex post facto" or previous case and facts.

Beside that, many other methods and tools were conducted like: knowledge discovery in data base, data mining, case base reasoning-CBR, object oriented programming, artificial intelligence tools, Analytic Hierarchy Process-AHP, expert choice, testing in real condition, Visual Basic and Select Query Language.

Through a detailed analysis of literature sources and software, it was found evident gap in applying artificial intelligence tools for improvement business process performances based on Quality Management System-QMS and especially in experience of other and case reasoning. In this research, analogy between human body function and process oriented organization were established, and areas in organization which is prior from the standpoint of improvement were identified. Two unique data bases and significant number of company and data, make original experimental value and bases for research. Also, new concept of

Degree of Readiness and Coefficient of Significance for achieving business excellence stay in the basis of new expert system for achieving business excellence. By applying this expert system, especially on prior area, employees should drive they process performances to excellent condition, even those of financial character. Also, many actions for improvement with appropriate coefficients which show theirs intensity where found. This action should be understood also like preventive action for strengthening organizational condition to avoid some failure in the system. This expert system was tested in real conditions in one very successful organization which will be participant in competition for European Award for business excellence. This test and verification showed that the system could be useful and also the efficient and effective

3. Experimental research, areas for research and reasons for developing expert systems

The basic facts of this research are attempted to define two levels of experimental data. The first level of the data is related to quality management systems and nonconformities that have emerged. This is a basic level of data which reflects the situation in the quality management systems and identify critical places that are subject to improvement. The base of these data is unique and consists of the **1009** nonconformities (cases), identified in over than **350** organizations. If we know that in our area in the field of competent certification body has, approximately 500 certificates, then the number of 350 is about **70%** of the total number. That fact points out to the significance of sample for analysis.

The term nonconformities refer to any non-conformance of requirements of ISO 9001, nonconformity non-fulfilment of a requirement [21]. During the external audits of quality management system, competent and trained auditors can identify several types of nonconformities (Figure 1). We are using most significant data from highest level of pyramid at which were collected at the level of many country like external estimation and evaluation of they performance and condition.

Distribution of nonconformities depends on the rules that define the certification body itself. However, for the purposes of this research is used classification which is the most common in the literature, which is favour by the authoritative schools in the world in the field of management system and that is clearly recommended by European guidelines in the subject area, which is split into three levels. The first level is the disagreements that are evaluated as insignificant deviations from the standards and requirements which are interpreted as an oversight or random error. The other two categories are interpreted as nonconformities that represent a great deviation from the essential requirements, which are reflected in the frequent discrepancies in individual requirements, representing a deviation that brings into doubt the stability of the management system and threatening the operations of the organization.

Data base of nonconformities which is under consideration in this research contains only nonconformities in the domain of the other two categories, and that giving greater importance to this research and gives greater significance results.

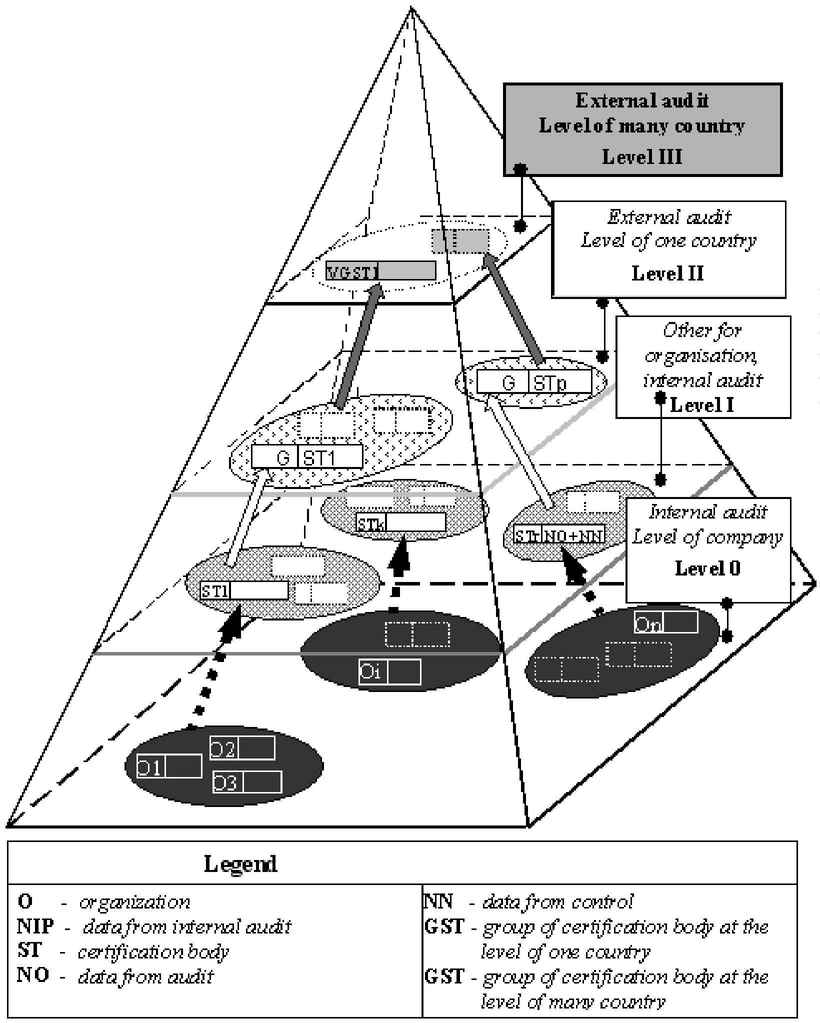

Figure 1. Data source (highest level of data significance)

Non-conformances are identified in accordance with the structure requirements defined in the ISO 9001 standard as follows:

- Quality management systems: 4.1 general requirements, 4.2 documentation requirements,
- Management responsibility (module 5): 5.1 management commitment, 5.2 customer focus, 5.3 quality policy, 5.4 planning, 5.5 responsibility, authority and communication, 5.6 management review,
- Resource management (module 6): 6.1 provision of resource, 6.2 human resources, 6.3 infrastructure, 6.4 work environment,
- Product realization (module 7): 7.1 Planning of product realization, 7.2 customer related processes, 7.3 design and development, 7.4 purchasing, 7.5 production and service provision, 7.6 control of monitoring and measuring devices,
- Measurement, analysis and improvement (module 8): 8.1 general, 8.2.1 customer satisfaction, 8.2.2 internal audit, 8.2.3 monitoring and measurement of processes, 8.2.4 monitoring and measurements of product, 8.3 control of nonconforming product, 8.4 analysis of data, 8.5 improvement.

Accordingly, for example in the field of 8.2.1 from the standpoint of the appearance of non-conformances organizations have a significant and frequent or large deviations in the sense that it does not follow the information about the observations of users, it did not define the methods for obtaining this information, they do not have strong communication with customers and similar. Or for example in the field of 8.2.3 with the observed aspect, organizations do not apply appropriate methods for monitoring and performance measurement processes, have not mechanisms for implementation of corrective measures in cases that have not achieved the planned performance of processes and the like.

This data will be used like the basis of CBR approach or approach where it is possible to make significant conclusion in the sense of main target of this research. This approach is shown in figure 2.

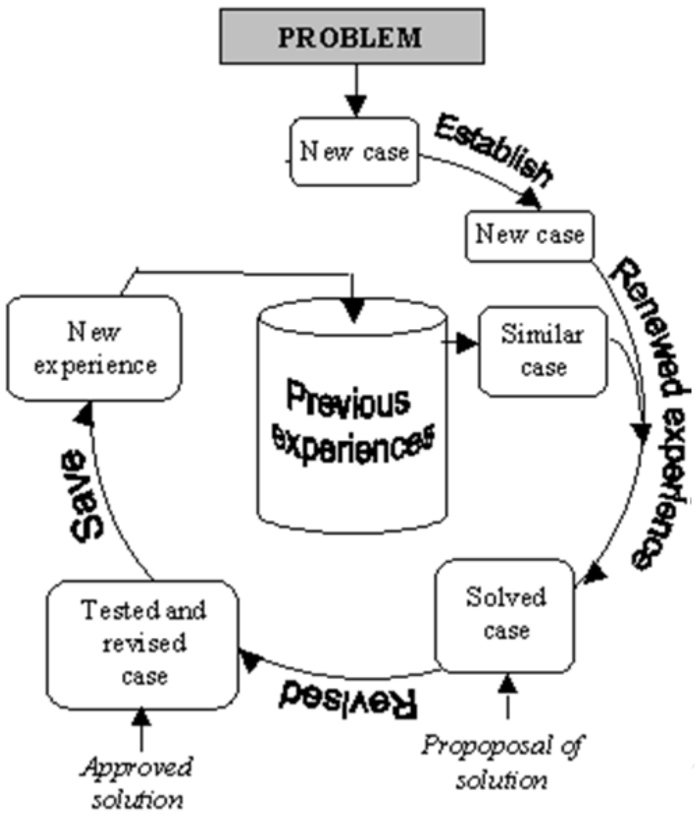

Figure 2. Case based approach

The second level of data consist data from evaluation organizations that participated in the competition for the quality award based on European Quality Award criteria. This database is unique, as well as in the previous case. Data were transferred in encoded form in order to secure the identity of the organization. Data were collected in 100% extent (34 organizations) and thus are significant and give a real picture of the situation in our organizations. These data are used for comparison with previous, basic level data. That is way for making improvement or exalt from basic level on the level of business excellence and way for making knowledge which reproduce expert system on his output. That is also comply with literature more existent attitude, and natural way that organization should first implement

Quality Management System and after that system which is based on Total Quality Management concept [22, 23-26, 27].

In order to show the current directions and trends in the field of development of software for quality, and to select under researched areas in the field of software quality, it was conducted a detailed review and analysis of a total of 143 software. All necessities information for that analysis are available in site (http://www.qualitymag.com) where are publish updated software items which are related to quality. The results of the analysis are shown in the figure 3.

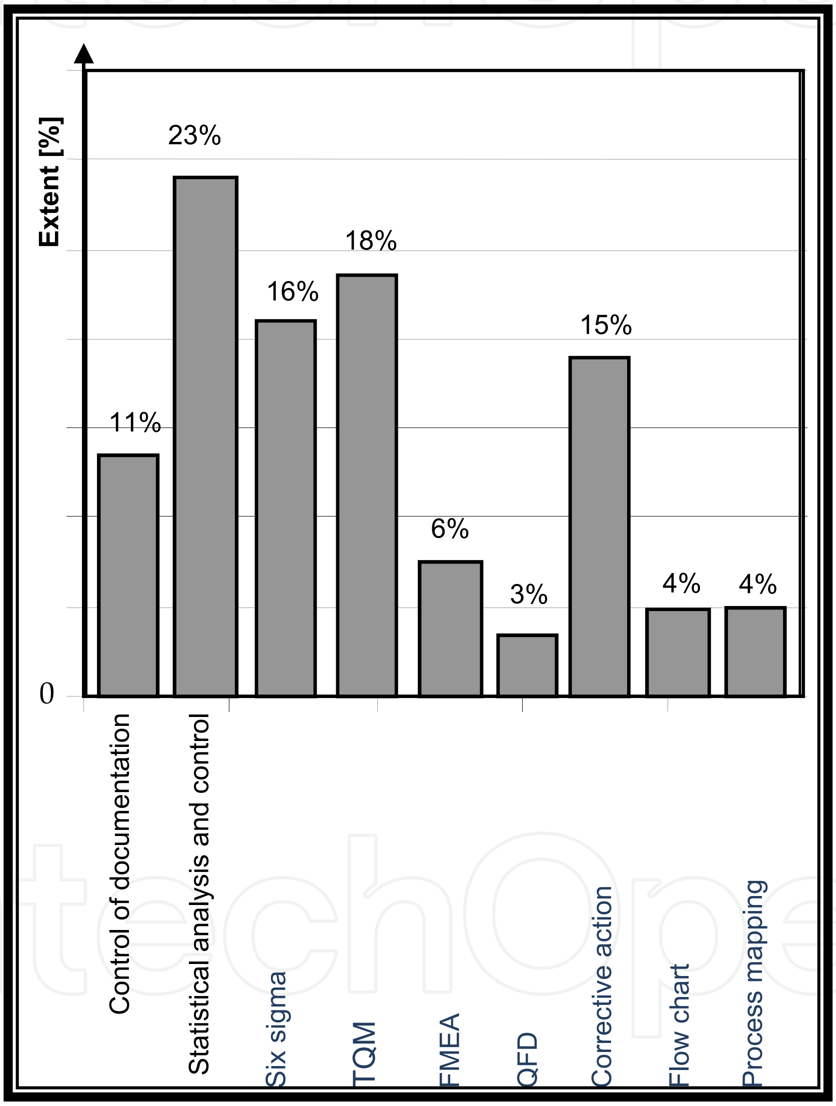

Figure 3. Results of analysis of existent software for quality

On the x axis diagrams are shown the software ability and orientation. Obviously is that the software in the field of quality is usually oriented to the control of documentation, statistical control and analysis, six sigma model, concept of total quality management, FMEA and QFD methodology, corrective action, flowchart and process mapping. However, there are specific tools for automation: the implementation of the quality management system documentation, description of information flow, implementation methods and techniques of quality, and more. Therefore, it can be concluded that there is no software that is based on the application of artificial intelligence tools in the sense of the definition of preventive actions for the purpose of improving the process. The greatest number of software is related to the application of statistical methods in the process of monitoring and improving quality. It is obviously that a large number of software is based on total quality management systems concept. The facts point out present approach which we develop in this research and also justify further research in this area. It is interesting that a large number of software are base on the corrective actions and on the other hand there is not any registered software that has application for output preventive action what is, of course, main recommendation of ISO 9000 series. This fact also gives stimulus in terms of development of software that emphasis to the prevention. That approach is unique in the field of software for quality and makes this research more significant.

Beside this analysis, in this research were analyzed huge amounts of available books in order to point out the justification of applying expert system. Expert systems are different from other artificial intelligence systems in that, they attempt to explicitly and unequivocally embody expertise and knowledge with the software [28]. Expert systems are also identified as one of the most commercial branches and in most number of projects used artificial intelligence tools [29, 30]. For example, it is estimated that in the first half of 21st century, even 75% of all legal documents be written with the assistance of expert systems [31]. Also expert systems will be of vital importance for measuring the quality of products and services [32-34]. Expert systems are an area of special importance with rise trends in modern business conditions [35, 36-38]. They have special significance in a highly developed countries where is actual knowledge based economy. This research highlight trends, significance and justification of developing and implementing expert systems.

Main idea and approach for developing expert system come from analogy between human body functions and process in some organization which was organized based on process modelling from ISO 9000 respect. This approach is present on figure 4.

This research tries to deal with perfection of functioning of the human body compare with a process modelling structures of the implemented quality management system. The challenge made in this way, tried to create a system that is universal for all sizes of organization, which incorporates a large number of gathered data, in fact a large number of experiences, in order to get a better image of the system status. This should be added to the primary goal which is to develop a model for improvement of management system, oriented to achieve BE according to show off how to maintain and improve the performance of the human body. However, the goal is also, to develop a system for measuring performance and capacity of each activity in the QMS, in order to obtain a true picture of the systems and capabilities in order to define the areas where improvements should be made, with clearly defined intensity of improvement. On the basis, thus established the analogy is made to compare elements of implemented QMS to the systems that have applied for Quality award for BE as a system with high performance.

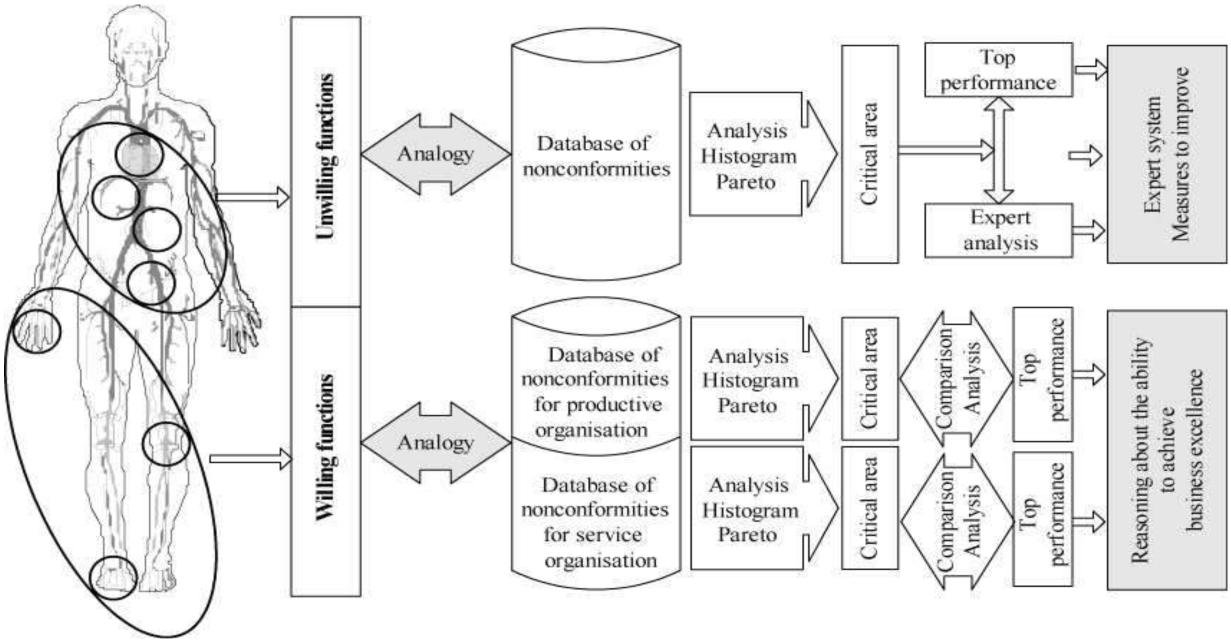

Figure 4. Analogy with the human organism in order to improve organizational performance

To establish the analogy between the process modulated organizational structure and the human organism, so as to create the system that is independent from organizational functions and based only on the process model, following division of man functions was made [39, 40]:

- willing and
- unwilling functions.

Willing functions (term "functions" is used in medical terminology, although it is equally correct, to use a term "activities" in view of ISO 9000 standard terminology. For reasons of consistent referencing and use of theories from the field of medicine, the author has chosen to use the term functions.) are those dependent on man's profession and performed by man's will. They are variable and dictated by a central control of the organism. For example, when a worker at the construction site lifts his hand, it is not the same as when a referee at the game lifts his hand and etc. Willing functions refer to functions of external motoric organs.

Second category is made of unwilling or automated functions and their use is given by their existence. There are functions that are same in all professions and all people (considering that they exist, i.e. that human body is in good health) and do not depend on the man will but are simply executed. For example, those are functions of secreting enzymes, hormones, heartbeats, and similar, like ordinary body functions, and functions that cannot be controlled [41, 42].

With such a ratio of functions in the human body, we can establish the analogy of the system with implemented quality management system. Analogy in term of willing function goes in direction to developed all data in to two category, production and service organization and make some analyses, which is not subject of this research.

In order to meet requirements of this research, only analogy in terms of unwilling functions has been considered. The idea is to use all nonconformities (undependable of organization type or size) and base on case base reasoning approach, make conclusion about readiness of systems to making some top form.

3. Approach to developing expert system

At the market today, we can find many tools for creating expert systems. These systems can be developed in a programmable environment through tools of type C + +, Visual Basic or some other programs which are related to development of expert systems. However, today are developed specialized tools for creating expert systems which allow a high degree of automation in process of developing expert systems. There are called expert system shells. From the standpoint of this research it was carried out choice of expert system shell from the aspect of next four criteria [43-45, Personal communication with group for consulting from London South Bank University, Business, Computing & Information Management, 2011):

- programmability,
- comprehensiveness,
- universality,
- price.

During the election, it was analyzed 58 shells. All information about shells are available on the Internet [2], and classified in a group of commercial shell. Detailed analyses were conducted separately for each tool through analyzing belonging site. For evaluation on the basis of the criteria it was adopted the scale of 1 to 5 where 1 is unsatisfactory grade. According to defined criteria as a most distinguished tool for the needs of the research was adopted ACQUIRE shell. That tool is non programming oriented and it has affordable price. This is a tool that supports the work of the Windows operational environment. It has possibility to develop all elements of expert system and supports forward, backward and combined chaining. For the presentation of knowledge it can be used production rules, the action table, or combined techniques. During a process of developing expert system, the role of engineer for knowledge took up first author, and the role of one expert took up second author. Also, as sources of knowledge were used following:

- experience from eleven prestigious organizations in the world of field of quality management systems, business excellence and organizational performance [46],
- guidelines from standards for improving organizational performance [47],
- best practices from auditing of ISO 9001 oriented system [48],
- experience and practice of organizations that participated in the competition for the Oscar of quality award [49],
- theory and principles of TQM [50],
- experiences that are listed in [51] and indicate the path to business excellence.

The expert systems are included and knowledge gained through many concrete practical projects of quality management systems implementation, and many training on that topic. That knowledge is next:

- knowledge that are specific to certain companies,
- knowledge derived from specific experiences and on specific way of solving problem,
- knowledge of those that are best for certain jobs and are passed special training,
- knowledge of those that is proven in practice for the specific job and similar.

For the purposes of this research, expert system was develop for modules 5 (management responsibility) and module 8 (measurement, analyses and improvement) of ISO 9001 standard. The reason for that is that these areas have the greatest importance in achieving business excellence [1] and therefore they should be considerate from the standpoint of improvement. Also, another reason is that module 8 has requirements that are oriented to the improvement and that is essence and priority.

The idea of this research is to make the integration of decision support systems (DSS) which is operate on first level of experimental data, and expert system. That is modern approach of integration a number of tools with the aim of acquiring a larger volume of better knowledge [52] and make system with higher level of intelligence. Today trends are integration expert systems and traditional decision support systems which as output give data and information [53].

Integration of expert systems and decision support system can be achieved in two ways [54]. The purpose of this research is to use model which is present on figure 5. based on the collection and analysis of data obtained at the output of the decision support system and it provide important information like one of inputs for expert system and its knowledge base. This is the model which is completely compatible with previous remarked analogy with human body. This two approach stay in base of this analogy integrative model for improvement business process performance.

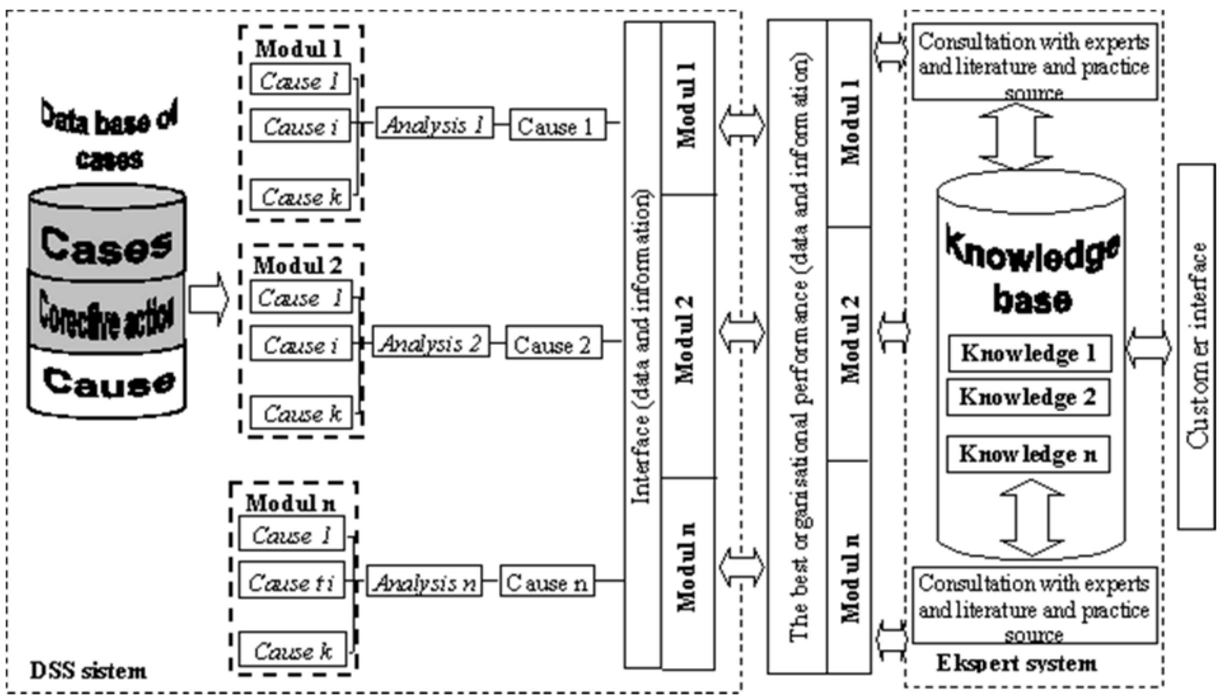

Figure 5. Integrative approach for merging expert system like separate part of DSS components

For the purposes of this research, we developed a decision support system in the MS Access, Select Query Language and Visual Basic environment. This system is base on the first level of experimental data, and like one of outputs it gives results which are present on figure 6 (for module 8).

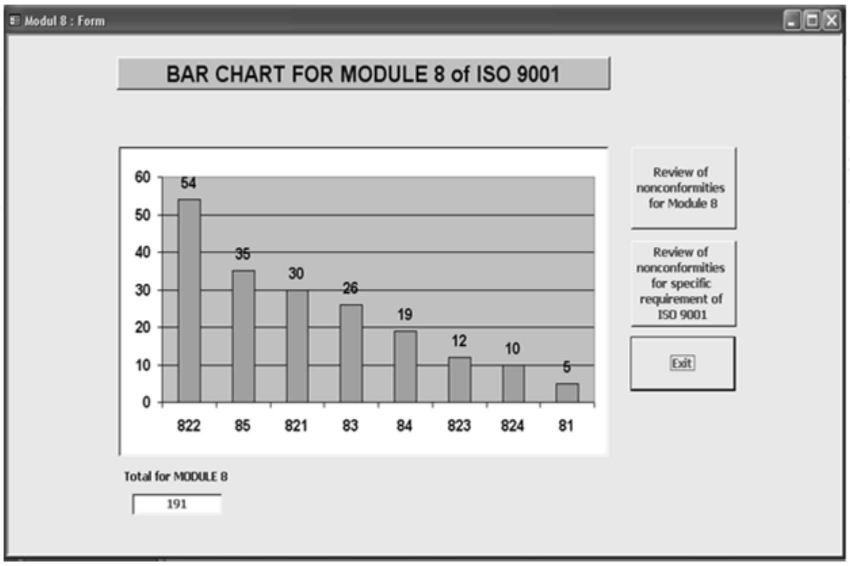

Figure 6. Results of DSS systems for module 8-measurement, analysis and

Applying Pareto method and rules of 70/30 it can be identified area which is crucial from the standpoint of improvement. Also, this system like support for making decision provides written presentation of nonconformities which can be shown as experience of other companies. That could be use like important data for the definition of knowledge in expert system. In addition, this system provides, and comparative analysis with the period of the four years before, which also has significance for the definition of knowledge in the expert system.

Connection between data from the first and data from the second level was achieved through the introduction of the concept of "Degree of readiness (Si)" in achieving business excellence, in accordance with the following expression:

$$S_i = N_z\left[\%\right] * K_z, \quad i=1,2,...,26 \tag{1}$$

where:

Si Degree of readiness for all type of organizations for all requests of ISO 9001

Nz Power of a standard clause in terms of percentage. Nz = f (number of nonconformities from experimental database)

Kz Coefficient of significance for achieving business excellence

That degree is applies to every single request of ISO 9001 and showing the willingness or the ability of organizations (both manufacturing and service sector) to attain business excellence in some areas. To find this degree, we are using method Analytic Hierarchy Process (AHP) and corresponding software Expert Choice. Results are shown in table 1.

Requests	Organization (power)	K_z	S_i	Requests	Organization (power)	K_z	S_i
821	66.67	0.090	**6.00**	83	50	0.036	1.8
823	50	0.075	**3.75**	52	40	0.035	1.4
85	37.14	0.072	**2.674**	81	60	0.033	1.98
84	57.9	0.066	**3.821**	822	46.3	0.032	1.481
54	48.72	0.064	**3.118**	73	76.19	0.026	1.981
824	40	0.064	**2.56**	61	100	0.022	2.2
56	44	0.059	**2.596**	75	37.5	0.022	0.825
53	70	0.054	**3.78**	64	63.64	0.019	1.21
71	56.52	0.04	**2.26**	76	44.68	0.018	0.804
41	65.22	0.038	**2.478**	62	62.07	0.008	0.496
51	72.73	0.038	**2.763**	74	52.94	0.008	0.423
72	56.76	0.038	**2.157**	63	50	0.005	0.25
55	66.67	0.037	**2.467**	42	49.26	0.005	0.246

Table 1. Review of the degree of readiness for all type organization in relation to every request of the standard

It is important to emphasize this because it was used and it is very important during definition of preventive measures in terms of defining their priorities and "power". Also, "power" of prevention was related with number of nonconformities in particular area. That means, larger number of nonconformities, or larger number of experience, make possibilities for defining more effective and efficient preventive action like output of expert system.

Through application of Pareto method, based on coefficient of significance following requests were identified as the most significant for achieving business excellence:

requests - 821, 823, 85, 84, 54, 824, 56, 53, 71, 41, 51, 72, 55

At the same time, this is important areas, and have high level of priority for improvement from the standpoint of achieving business excellence and it is very important for defining preventive action of expert system and intensity of that action. If we take a look at the list of "Coefficients of significance" for business excellence achieving, especially the most important ones and perform comparison with the list of variables and their significance in terms of: Business Process Reengineering (BPR), manufacturing strategy, benchmarking and performance measurement, being the result of the appreciated research [55] and [56] it may be found significant intercompatibility.

The concerned compatibility is especially reflected in the following variables, evaluated in the relative research as highly significant for the following four projects, *i.e.:* customer satisfaction, quality, employee satisfaction and personal growth, customer adaptability, identification of top managers with BPR goals, strong process orientation, results orientation, direct customer cooperation. On the other hand, the above mentioned four areas are considered as highly important for any market-oriented organization, thence it can be concluded that organizations by strengthening their capacities in areas of presented "Coefficients of significance" (especially the most important ones), are not only strengthened in terms of the business excellence achieving as per European Award model, but also in the stated four areas.

But some of these areas are much more important then other. Because that, the research was further elaborated in order to indicate most important area for improvement and area where should be focus attention and where should be provide very intensive action in order to achieve best organizational condition and results. This research was conduct from the standpoint of occurrence of nonconformities in all type of organisation regardless of they size or type (both for manufacturing and service organisation). Parallel the Pareto method (70/30) was carried out in that direction and based on that, it was identified next areas:

requests - 56, 75, 62, 822, 74, 76, 54, 72, 85, 821, 55, 63

Now we are search for common requests (area) that are most important and where should be oriented focus and where should be provide extensively action in terms of achieving business excellence regardless of type or size of organization. And they are:

1. 821 – customer satisfaction,
2. 72 - customer related processes,
3. 54 – planning,
4. 85 – continual improvement,
5. 56 – management review and
6. 55 – responsibility, authority and communication.

This area is most important for defining output of expert system and for defining intensity of action for improvement.

Objects were defined during the process of expert system developing. That were depend of problem which should be solved, base on ISO 9001 oriented check list an based on experience which can be find on DSS output. Base on results of DSS system, it is defined value of the object and relation between them. In that way, it is created decision tree, which is present on figure 7.

At the end, after starting the program, in a short time, system introduce user in a set of dialog boxes. One of them is shown on figure 8.

Depend on the answers, expert system produce user's report, like one which is presented on figure 9.

Data obtained from this report, user can use and implement knowledge that an expert system produces. However, users can improve performance of an organization in the field where such as performance are on lower level. Also, it can be improvement performances of other, non critical, area and can be reach level of business excellence.

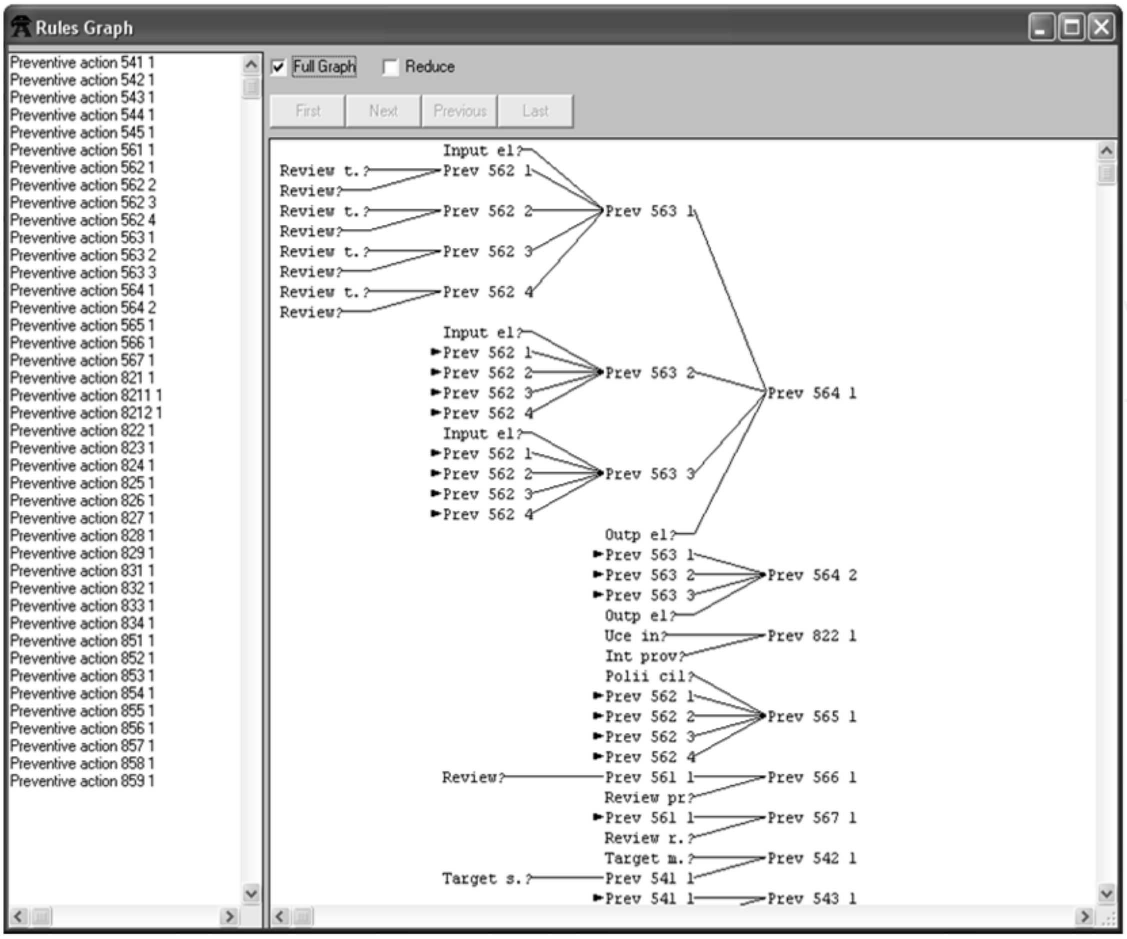

Figure 7. Decision tree

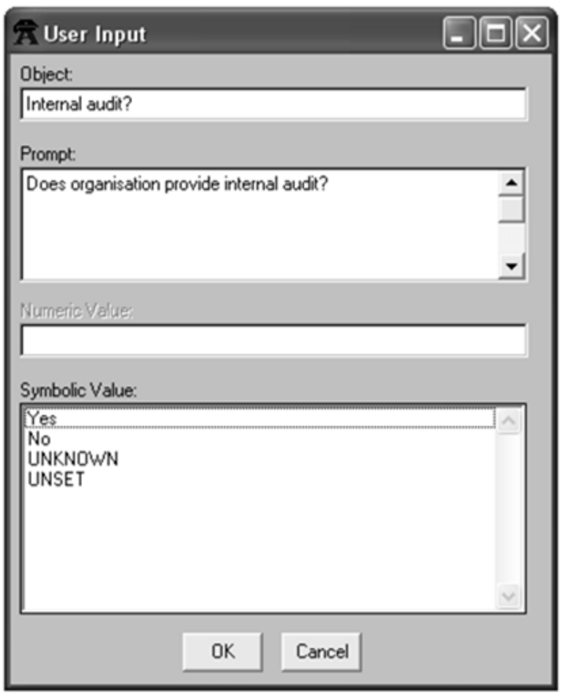

Figure 8. User's dialog box

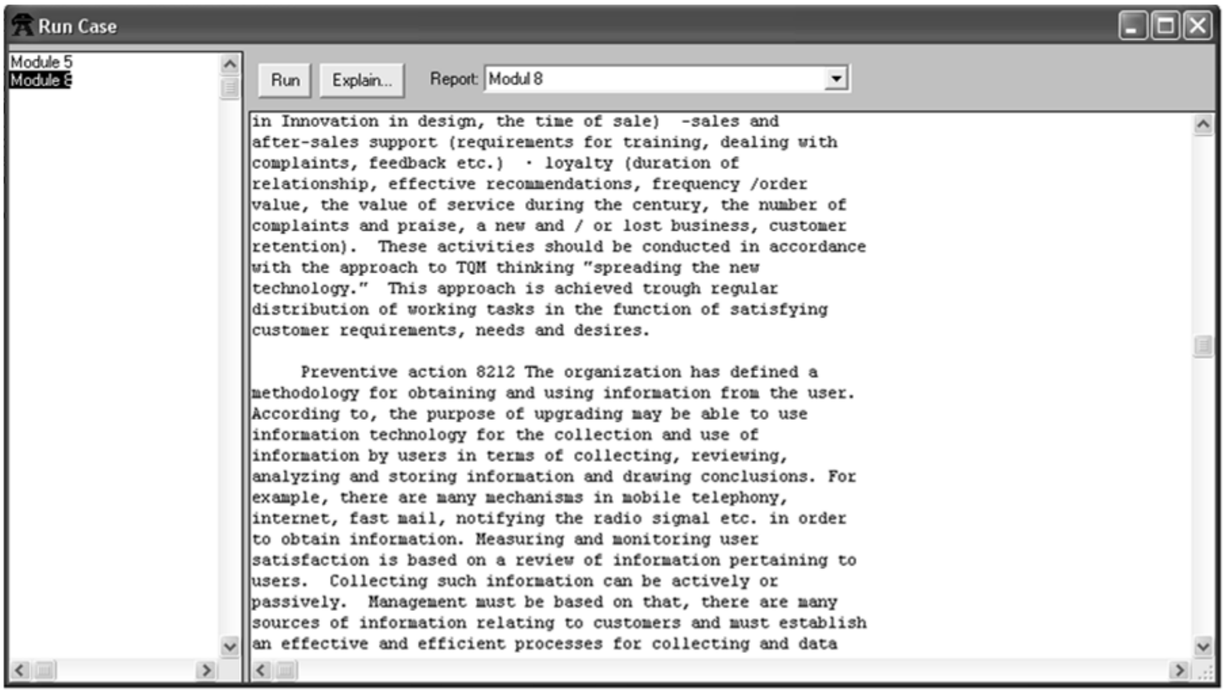

Figure 9. User's report

This expert system was developed in three iterative steps. Each of them resulted of the improvement, for example improvement of the definition of objects, set the input data, the relation between objects depending on the priorities of execution and more.

The expert system was implemented and tested in practical, real conditions in the organization that has a clear commitment to participate in the competition for the European Award for Business Excellence, also providing important measures in that direction. Evaluation was done on the basis of technical and ergonomic characteristics based on guidelines in standards ISO/IEC 9126/1:2001 for evaluation quality of software. The results are shown in Table 2.

<table>
<tr><th></th><th>Category</th><th>Awerage mark</th><th>Awerage mark</th><th>Total awerage mark</th></tr>
<tr><td rowspan="3">Technical characteristic</td><td>Fault of presented software</td><td>8.2</td><td rowspan="3">8.7</td><td rowspan="5">9.2</td></tr>
<tr><td>Benefit of new software</td><td>8.7</td></tr>
<tr><td>Influence on job organisation</td><td>9.2</td></tr>
<tr><td rowspan="2">Ergonomic characteristic</td><td>General ergonomic characteristic</td><td>9.8.</td><td rowspan="2">9.7</td></tr>
<tr><td>System adaptability</td><td>9.6</td></tr>
</table>

Table 2. Results of expert system evaluation

Figures showed significant high mark by categories, and thus the total amount. Software was evaluated positive in terms of technical characteristics and in terms of ergonomic. In this sense, product has small time of response, it is compatible with most used operating system, it has an excellent user's oriented interface, and it has easy data entry and a good view of the output, installation is simple and the software is very competitive. Also, in this sense, within the organization, it was carried out the reorganization of the priority areas from the viewpoint of improvement, implemented preventive measures for the potentially unstable areas and also applied the measures for the improvement (offered by this system) leading to business excellence achieving.

4. Final considerations

Nowadays, very small number (a few per cent) of the scientific research activities in area of quality management systems are based on topic of the collection and analysis of information with aim to improvement business results. That fact justify author's effort to make preventive actions for improvement business performances through establishing synergy between area of quality management and artificial intelligence like area which is strictly oriented on producing knowledge. Also, through analysis of the available software for quality management, it can be concluded that there are no any software from field of artificial intelligence that was developed for quality management systems improvement. That means that each further step in this direction brings positive scientific research results. The research point out necessity of making connection between more software solutions and tools in order to make the system with a higher level of intelligence. For this purpose, it is best to apply the integration of decision support systems and expert system. That is best world experience. With this approach it can be make system that producing knowledge and that is greatest resource which can make organization more competitive and can ensure improvement of organizations performances. Based on those facts in this research we developed unique analogy integrative approach which stays in the basis of model for improvement business process performance in the direction for achieving best organizational performances.

As the most important requests for achieving business excellences were identified requests which are mostly related to: measurement, analysis and improvement (module 8 - ISO 9001) and management responsibility (module 5-ISO 9001). The next area is most important for excellence organizational condition and at the same time area where should make very intensive action for improvement and strengthening: 821 – customer satisfaction, 72 - customer related processes, 54 – planning, 85 – continual improvement, 56 – management review and 55 – responsibility, authority and communication. It is interesting to highlight, that all activities and process which is related with customer and achieving his satisfaction and anticipation his needs, are in the focus and that should be direction and guidelines for all employees.

Also, it is shown that the strengthening, especially in these areas is used to lead to the significant progress in terms of: business process reengineering, manufacturing strategy, performance measurement and benchmarking, as very important aspects of market-oriented organization.

This research present interesting and useful results which should be use for defining measurement for improvement business performance in way for achieving business excellence. Those results are related with term of Degree of readiness which show part (every request) of ISO 9001 certified model and they ability for achieving top business form. Also, interesting results are present through values of Coefficient of significance. This two indexes show direction about area and intensity of action which should be provide to make best organisational condition.

In organizations that have specific information through database and information systems, it is necessary to develop systems that will assist staff in decision making. These systems provide data and output information on the basis of which, in accordance with the principle of decision making base on fact, the employees make business decisions that certainly contribute to improve organizational performance. However, in the today complex business condition, organization must make stride from level of data and information to level of knowledge. That is way for ensuring prestigious position on the market. That could be achieving through development expert system base on expert knowledge and base on output of decision support system.

This approach could be related with one modern approach, which calls case base reasoning. This approach is base on experience of other companies, and that approach could be use for defining preventive action. In this sense, it can be use a system that was developed in this work. That system was testing in real condition and proved to be very useful and that showed great level of efficiency and effectiveness for real business conditions. According to process of testing and estimation, users of the system were put ratings that are present in table 2. They indicate that this system can: make financial benefits, provide better organisation of job, stimulate all employees to improving own process, synchronise function in organisation, identify priority area for improvement, define intensity of action for improvement, stimulate preventive versus corrective action, encourage better involvement of new staff in to the activities, bring higher level of flexibility and other.

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Chapter 2

Improving 'Improvement' by Refocusing Learning: Experiences from an –Initially-Unsuccessful Six Sigma Project in Healthcare

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Additional information is available at the end of the chapter

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1. Introduction

The Skaraborg Hospital Group (SkaS) is the first hospital group in the Nordic Countries that has added Six Sigma on a large scale to its quality programme to improve care processes (Lifvergren et al. 2010). Unlike many change efforts in the healthcare sector that are neither successful nor sustainable (Chakravorty 2009; Øvretveit 2009, 1997; Thor et al. 2007; Zimmermann and Weiss 2005), the success rate of improvement projects in the programme in this period was 75%, in some respects due to lessons learned from this particular project.

Still, the high success rate of the programme might be surprising, given the fact that the presumed success of planned or programmatic change has been seriously questioned in a number of articles and books (Alvesson and Svenningson 2007; Beer et al. 2000; Beer et al. 1990; Dawson 2003; Duck 1993; Kotter 1995; Schaffer et al. 1992; Strebel 1996). It is argued that organizations are not rational entities where people do as they are told and follow the latest strategic 'n-step model' –on the contrary, organizational change is to a high degree seen as contextual and processual, unpredictable and beyond the realms of detailed plans (Alvesson and Svenningson 2007; Dawson 2003; Stacey 2007). The culture and history of the actual organization define what strategies for change are possible. What may work in one organization might be impossible to carry out in another. In other words, improvement strategies seem to be notoriously difficult to transfer between organizations.

Change and improvement is about learning and apparently, organizations seem to have difficulties to learn. Furthermore, daily problem solving activities may inhibit organizational learning (Tucker et al. 2002). It is difficult for organizations to recognize and capitalize on the learning opportunities posed by operational failures (Tucker 2004) and the how-aspect of learning is vital in this respect (Tucker et al. 2007). Creating arenas for learning in a non-punitive climate is thus critical and the role of the managers is essential in this respect (Tucker et al. 2007; 2003). Consequently, we see learning as a crucial perspective in change and improvement programmes. A better understanding on how learning can be facilitated in organizations is thus essential.

In this chapter, we describe how an enhanced focus on learning through 'learning mechanisms' (Docherty and Shani 2008; Shani and Docherty 2008, 2003) has contributed to the high project success rate of 75% in the Six Sigma programme at SkaS. We present the analysis of a traditional Six Sigma project that failed initially, but eventually led to an enhanced approach emphasizing learning. This entailed a refocusing on actively planning for learning within and between projects – 'learning by design'– involving the integration of cognitive, structural and procedural learning mechanisms (Docherty and Shani 2008; Shani and Docherty 2008, 2003). The ensuring success from utilizing learning mechanisms inspired us a) to redesign the Six Sigma roadmap –DMAIC, incorporating an 'L' for 'learning mechanisms' – DMAICL, b) to establish permanent arenas for learning between organizational units and, c) to institutionalize parallel learning networks consisting of specially educated improvement managers that support and facilitate local improvement projects. We suggest that learning mechanisms can provide a useful framework to the how-aspects of learning (Tucker et al. 2007) when designing organizational change initiatives that leave room for the cultural and historical contexts inherent in every organization.

We will first, however, give a brief overview of Six Sigma before moving on to the theoretical underpinnings of this chapter – cognitive, structural and procedural learning mechanisms. The concept of learning mechanisms is explored in some detail, connecting theories of organizational learning to learning mechanisms, thus elucidating the application of the mechanisms as a way to enhance organizational learning. These theories are then positioned in relation to theories of individual learning and of improvement cycles in quality improvement.

The context of the project is then described in some detail; SkaS, the Six Sigma quality programme, and the actual emergency ward (EW). We then describe the actual improvement project and its initially failed results before moving on to the project analysis using an action research approach. We then present how lessons learned from the analyses were used to integrate learning mechanisms in the Six Sigma programme, thus contributing to its high project success rate. In particular, we present how the analysis contributed to a successful re-take on the project. We conclude with some proposals that might be valuable to other healthcare organizations facing the difficulties of larger change initiatives and, finally, provide some suggestions for further research.

2. Theory and background

2.1. Six Sigma

There are many definitions of Six Sigma in the literature. Antony et al. (2007) defines Six Sigma as "a process-focused data driven methodology aimed at near elimination of defects in all processes which are critical to customers" (p. 242). According to Harry and Schroeder (2000) "Six Sigma is a disciplined method of using extremely rigorous data-gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them" (p. 23). Recent research also points to the parallel organizational structure that supports improvements within Six Sigma (Schroeder et al. 2008; Zu et al. 2008). Based on case study data and literature, Schroeder et al. (2008) more specifically define Six Sigma as "an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives" (p. 540). This definition also captures some of the elements that distinguish Six Sigma from TQM —the role structure and the structured improvement procedure (Zu et al. 2008). The role structure is often referred to as the 'belt system' and could be seen as a way to standardize the improvement competences in an organization. The black belt role signifies a co-worker with advanced improvement knowledge, working fulltime as an improvement expert. The structured improvement procedure – DMAIC (Define-Measure-Analyze-Improve-Control) –is used to solve quality problems of greater complexity and with unknown root causes (Schroeder et al. 2008). The Define phase identifies the process or product that needs improvement, while the Measure phase identifies and measures the characteristics of the process/product that are critical to customer satisfaction. The Analyze phase evaluates the current operation of the process to determine the potential sources of variation for critical performance parameters. Improved process/product characteristics are designed and implemented and cost/benefit analyses are carried out in the Improvement phase and, finally, the solutions are documented and monitored via statistical process control methods in the Control phase (Dahlgaard and Dahlgaard-Park 2006; Schroeder et al. 2008). Iterations of the procedure are sometimes necessary but also desirable for successful project completion. Significant for this and other descriptions of the DMAIC roadmap is the instrumental approach oriented towards tools and procedures (see e.g. Antony et al. 2007; Dahlgaard and Dahlgaard-Park 2006; Schroeder et al. 2008; Zu et al. 2008). However, the how-aspects of learning in the improvement cycles are seldom explored or described (Antony et al. 2007; Dahlgaard and Dahlgaard-Park 2006; Schroeder et al. 2008).

2.2. Using learning mechanisms to enhance organizational learning

Unquestionably, organizational learning has been described, defined and studied in many ways and from different theoretical angles (e.g. Argyris 1999; Argyris and Schön 1978; Crossan et al. 1999; Dixon 1999; Friedman et al. 2001; Garvin 2000; Hedberg 1981; Senge 1990; Weick 1995). Many psychologists maintain that only people can learn, though organizational theorists refer to 'organizational learning' by attributing the term to observable changes in the structures, procedures and formal frameworks of the organization, expressed in such documents as policies, strategies and value statements, when theses changes can be clearly related to preceding events and developments in the organization.

Many studies have shown that learning at work, like learning in formal educational settings, is a matter of design and not evolution (Docherty and Shani 2008; Ellström 2006, 2001; Fenwick 2003; Shani and Docherty 2008, 2003). That is, it is a matter of organizing the workplace, not only for production, but also for supporting learning at work. Most studies of learning at work focus on individual workers. Crossan et al. (1999) provide a '4 I' framework that links individual learning (Insight), through networks of collective or group learning (Interpretation and Integration) until it meets a senior management group whose decisions make important changes in the organization (Institutionalization), that is termed 'organizational learning'. Shani and Docherty (2008, 2003) use the term 'learning mechanisms' for the preconditions that are designed to promote and facilitate individual, collective and organizational learning. They use three main categories; cognitive, structural and procedural. *Cognitive mechanisms* are concepts, values and frameworks expressed in the values, strategy and policies of the organization and, ideally, underpin the practice-based learning processes at different organizational levels. *Structural mechanisms* are organizational infrastructures that encourage practice-based learning. An example would be lateral structures that enable learning of new practices across various organizational units. Finally, *procedural mechanisms* concern the routines, methods, and tools that support and promote learning, e.g. the introduction and, eventually, the institutionalization of a new problem-solving method. Learning mechanisms in practice may include more than one of these components, e.g. both structural and procedural (see e.g. Lifvergren et al. 2009 for an application of learning mechanisms in healthcare). In other words, learning mechanisms aim to encourage individual and collective learning eventually leading to organizational learning.

Thus, *individual* learning is a prerequisite for organizational learning. Without doubt, individuals can learn and learning takes place in iterative action/reflection cycles (or loops). Moreover, researchers who maintain that organizations can learn relate this directly to human learning, i.e. the learning of organizational members (Argyris and Schön 1978; Huzzard and Wenglén 2007; Kolb 1984; Shani and Docherty 2003).

Argyris and Schön (1978) take their departure from the concept of 'single – and double loop learning', where the former refers to our adaption of activities without questioning the 'a priori' – our taken-for-granted assumptions. Consequently, the latter signifies the alteration of our preconceptions in order to act or behave in new ways (ibid. 1978; but also Argyris 2001; Huzzard and Wenglén 2007).

Kolb (1984) pictures learning in an iterating four-phase cycle (or, rather, spiral), where learning is depicted as the interplay between theoretical knowledge that leads to activities (experiments), generating new experiences. These experiences further inform reflection, leading to new knowledge.

2.3. Learning cycles in continual improvement

Beyond doubt, there is a close connection between theories of learning and the improvement cycles of quality improvement. At the core of every quality programme, including Six Sigma, lies the concept of Continual Improvement, CI, in which learning cycles (or loops) should be used in every problem solving process (Bergman and Klefsjö 2010; Bergman and Mauleon 2007).

Already in the 1930s, Walter Shewhart proposed that mass production could be seen as constituting "a continuing and self-corrective method for making the most efficient use of raw and fabricated materials" (Shewhart 1939, p. 45). By repeating the steps of specification –production – inspection in a continuous spiral, a circular path representing 'the idealized state' could be reached. Deming (1986), inspired by Shewhart, proclaimed that the management should construct "an organization to guide continual improvement of quality", in which a four-step cycle, the 'Shewhart-cycle', should be utilized (p. 88). In other writings by Deming, this cycle is referred to as the PDSA-cycle (Plan, Do, Study, Act), see e.g. Deming 1994, where 'Act' also signifies reflection and learning. Similarly, Joseph Juran highlighted the importance of quality improvement, meaning "the organized creation of beneficial change" (1989, p. 28). All improvement should take place "project by project", where a project is defined as a "problem scheduled for solution..." (ibid., p. 35), and in which recurrent learning cycles should be applied. In Japan, the concept of CI, partly inspired by Juran and Deming (see e.g. Bergman and Klefsjö 2010), has been deeply ingrained in quality initiatives since the 1960s. Imai elucidated 'kaizen,' signifying "ongoing improvement involving everyone, including both managers and workers" (1986, p. 3) using the continuation of the Deming wheel: "Japanese executives thus recast the Deming wheel and called it the PDCA wheel (Plan, Do, Check, Act), to be applied in all phases and situations" (ibid., p. 60). According to Imai, the concept of Kaizen has been the most important and distinguishing feature of the Japanese quality movement. The DMAIC roadmap of Six Sigma shares the same origin from Shewhart and can be seen as an extension of the PDSA cycle and an enhanced version thereof, often used in the Japanese improvement descriptions, the QC-story (Bergman and Klefsjö 2010, Smith 1990). Evidently, Shewhart as well as Deming brought forward the importance of learning in the iterating PDSA cycles of today's CI, emphasizing the importance of action as well as reflection on the action (Bergman and Mauleon 2009, 2007).

3. Method

3.1. Action research

In this project, an action research approach has been used. Action research could be described as an orientation to inquiry where the intention to improve the studied system is achieved by designing iterative action-reflection loops involving both the researchers and the practitioners in the workplaces involved in the projects. The research question usually stems from problems that need to be solved in the studied organization. In action research projects, researchers and co-workers share a participative community, in which all the members are equally important in generating actionable knowledge. Co-workers are thus considered to be co-researchers in the inquiry process. The purpose of action research projects is mainly twofold; to generate actionable knowledge that help to solve the local problem, but also to contribute to the body of generalized knowledge (Bradbury and Reason 2008). Two project workshops were used in this research, see section 5, where a co-generative model inspired by Greenwood and Levin (2007, p. 93) and Lewin (1948, p. 143-152) was used.

Emanating from the action research framework already described, a co-generative dialogue starts out from a distinct problem definition where outsiders, in this case the project mentor, the development director and an insider through mutual reflection and learning try to solve the problem. The solutions are formulated and tested using iterative reflection-action loops to further enhance the creation of opportunities for learning and reflection.

4. The context: The Skaraborg Hospital Group and the Six Sigma quality programme

4.1. SkaS

The Skaraborg Hospital Group, (SkaS), is situated in the Western Region of Sweden and serves a population of 260 000 citizens. The group consists of the hospitals in four towns, Lidköping, Skövde, Mariestad and Falköping. The services offered by SkaS include acute and planned care in a large number of specialties. In total there are more than 700 beds and around 4500 employees at SkaS. There are two emergency wards (EW) in two separate hospitals at SkaS. Each ward is responsible for all aspects of acute care in its constituency.

SkaS have a long tradition of quality development using different types of quality improvement approaches, such as TQM, organizational audits, small scale improvement cycles, the Collaborative Breakthrough Series (IHI 2003). Still, in 2005 it was unclear if the many improvement efforts contributed to the realization of the overall quality strategy. In many cases, poor formulation of project goals made it difficult to assess whether the improvement initiatives had failed or succeeded. Furthermore, the economic outcomes from different improvement efforts were not measured. Drawing on these experiences and inspired by a pilot Six Sigma project in 2005 (Lifvergren et al. 2010) the senior management team decided to add Six Sigma to the SkaS quality methods tool box. Six Sigma would contribute to the quality strategy by systematically searching for and reducing unwanted variation in critical healthcare processes, and by sustaining an even flow in the processes. More than 50 black belts have been trained at SkaS in the period from 2005 to 2010. Half of them now work as fulltime internal consultants leading various improvement efforts at SkaS.

SkaS also initiated an action research collaboration with Chalmers University of Technology in 2006 to explore how Six Sigma can be embedded in a healthcare setting and to improve the DMAIC-roadmap to better correspond to healthcare process improvement.

4.2. The initial project at the emergency ward

From a patient's perspective, long patient waiting times at emergency wards (EW) are unacceptable. Studies have shown that the mean patient Length of Stay (LoS) at an EW correlates to increased morbidity and mortality (Sibbritt and Isbister 2006). At one of the EWs at SkaS, the LoS was increasing during 2005. An analysis revealed that about 16 000 patients were treated that year. The average LoS at the EW during the first six months was 2.7 hours. Furthermore, the variation in LoS was also significant. Nearly 10% of patients had a LoS of five hours or more, and almost 20% had a LoS of more than four hours.

To address the problem the owner of the emergency process at the EW - the manager of the surgical clinic - decided to start an improvement project in the spring of 2006, aiming to decrease the mean LoS by 20 minutes, thereby increasing patient satisfaction and safety, improving working environment and improving resource utilization. A reason for this initiative was that LoS at EWs was a topic that appeared frequently in the national patient safety discourse. The project group consisted of interested co-workers at the EW and was led by two internal black belts. A steering committee consisting of the medical and surgical clinical managers was established. The first line managers responsible for the different clinics in the emergency department followed the project.

The daily operations of the EW are admittedly complex. About 16 000 cases pass through the department each year, and each patient is unique. Some patients must receive immediate treatment in the EW, while others' treatment is less pressing. The inflow of patients varies from week to week, depending on such factors as the weather (e.g. slipperiness in the streets), epidemics (e.g. influenza) in the population and healthcare articles in newspapers. The EW is also heavily dependent on a well-functioning collaboration with other units –primarily the x-ray department and the laboratory unit –to achieve an even flow through the department. The complex operations sometimes lead to increased LoS, which is worrying, tiresome and potentially dangerous to the patients. A high inflow of patients also contributes to a stressful working environment. In addition, increased LoS put a higher demand on the resources at hand. When there is an accumulation of patients due to different bottlenecks, the tail of the patient flow has to be handled late at nights at a higher cost.

The EW is organized under the surgical clinic; nurses and assistant nurses are employed at the EW whereas the doctors responsible for the EW come from the medical and the surgical departments following a scheme for emergency duty. There are two on-duty lines; the primary doctor on duty (usually a resident) works together with front line staff at the EW, whereas the secondary doctor (a senior physician) is on standby duty, always reachable by phone and obliged to appear within 20 minutes at the ward if called for.

The DMAIC roadmap of Six Sigma was used to assess the emergency process in order to detect root causes explaining the long waiting times. Several tools and methods were used; process analysis of the patient flow, e.g. how the inpatient clinics responded to a request to admit a patient; analyses of different lead times in the process, e.g. patient in need of x-ray.

Interviewing members of the project group, the information flow in the departments was also analyzed. The most important reasons for prolonged LoS were:

a. Patients that should be admitted had to wait too long for the doctor's examination;
b. the waiting times for patients in need of x-ray were too long;
c. patients with fractures had to wait too long for pain-relieving treatment;
d. the communication between doctors and other co-workers at the EW was poor;
e. new residents were not introduced to the procedures used at the EW and;
f. there were no clear rules for when the secondary doctor on-call should be contacted.

With these root causes in mind, several improvements were suggested and implemented, e.g. nurses should be allowed to remit the patient for x-ray in case of suspected hip fractures and they should also be permitted to give pain-relieving treatment to these patients without consulting a doctor. A common routine for the improved communication between different categories of staff was created. In addition, a mandatory introduction program for intern doctors was developed in which important routines at the emergency ward were taught. The proposed solutions were shared with co-workers including the physicians at regular work place meetings. The results of the proposed solutions were monitored using control charts, continuously assessing the overall LoS. Random inspections were also used to make sure that the proposed solutions were implemented.

5. Results and analysis of the project

5.1. Initial results show no improvement

Surprisingly, the LoS at the EWwere not affected at all but appeared to increase during the first three months after implementation of the suggested solutions by the initial Six Sigma project. It was the only one of eight on-going projects during 2006 that did not produce any positive results (Lifvergren et al. 2010). In order to learn from the initial failure, a deeper analysis of the project was carried out to reveal the causes of the failure and to improve the conditions for future projects. The development director (Svante Lifvergren) initiated the analysis. Two workshop dialogues, inspired by the co-generative model, were carried out. The purpose of the dialogues was to reveal the reasons to why the project had not succeeded so far. In the first workshop the development director, the supervisor of the Six Sigma program and one of the project managers participated. The second workshop also included the clinical manager and the assistant clinical manager at the surgical department, the other project manager and the manager at the EW. The results of the dialogues were also discussed with the outsider researchers, in this case Bo Bergman. Several plausible reasons explaining the failure of the project could be agreed upon (see figure 1).

The causes could be categorized into two groups; 'failure of implementation' and 'insufficient analysis'. These groups where then subdivided according to the figure and the relations between the different subgroups were visualized using arrows, thus showing the believed cause and effect relations between the subgroups. Each subgroup was further investigated using '5-why' in repetitive root cause analyses, depicted below (Table 1).

Subgroup(s)	Root cause analysis	Probable root causes
Poor project information at the EW and Lack of commitment	Lack of commitment among the ward manager, the physicians and the co workers »» (due to) poor knowledge of the usefulness of the project »» poor information about the project »» the information about the project from management was insufficient »» the management did not realize that the information had not reached all co workers »» poor management knowledge of the importance of project communication and how this should be accomplished /visual engagement from management in project was lacking	1. Management knowledge of the importance of project communication and how this should be accomplished was lacking 2. Poor management knowledge of the importance of physically being involved and showing engagement in the project
Poor support for the local project group	The project group lacked authority »» strong informal leaders didn't commit to/support the project (co-workers at the EW as well as physicians) »» management was not able to convince key personnel about the importance of the project »» management did not realize the importance of recruiting key personnel to the project group or to communicate to informal leaders about the project »» the project managers also lacked this knowledge »» not enough focus on project stakeholder issues early on in the Six Sigma education at SkaS	3. Not enough focus on critical project stakeholder issues early on in the Six Sigma education
Other methods not exploited	Project managers lacked knowledge of and experience from other methods and concepts, e.g. lean, discrete simulation, Design for Six Sigma etc. »» to learn the DMAIC-roadmap was time consuming »» project managers lacked time to study other methods »» the education was too compressed and did not contain other methods	4. The Six Sigma education was too compressed and did not contain other methods as well
True root causes not found	Data and risk analyses insufficient »» no actual root cause analysis from data »» insufficient amount of data »» project scope too large »» not enough time to gather data »» the project mentor did not give enough support to the project managers in helping them delimiting the scope of the project but also in suggesting alternative methods »» poor communication between mentor and project managers and inexperienced mentor	5. The project mentor did not give enough support to the project managers in helping them delimiting the scope of the project but also in suggesting alternative methods 6. Poor communication between mentor and project managers 7. Inexperienced project mentor and project managers

Table 1. Root cause analyses in the different subgroups

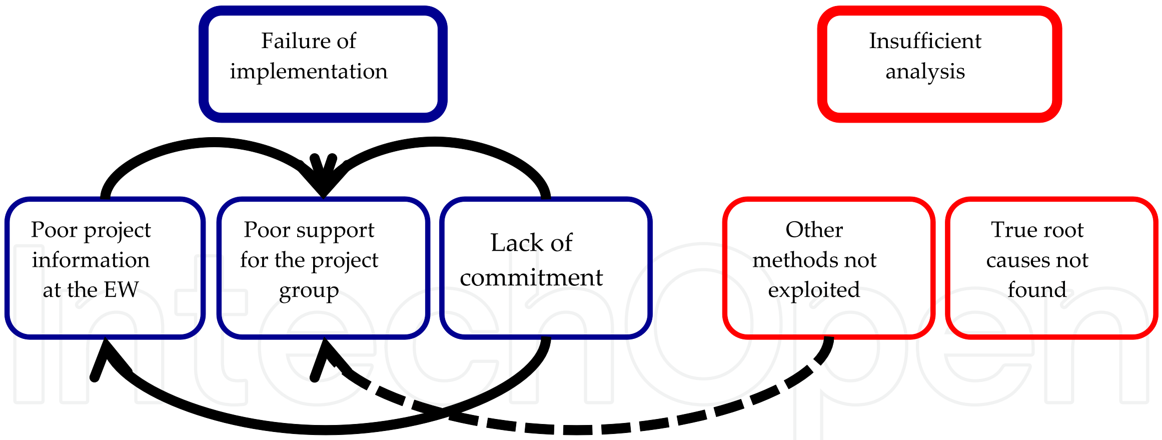

Figure 1. An affinity diagram from the workshops displaying probable causes of the, initially, failed project

6. Integrating learning mechanisms into the SkaS quality programme

Although only this project initially failed in its impact on the operational units concerned during 2006, we believe that it was the most successful through its impact on the hospitals' development strategy and procedures, especially regarding the design and integration of learning mechanisms – cognitive, structural and procedural – into the ongoing quality program at SkaS. The lessons learned were used to redesign the Six Sigma solving process – cognitive and procedural mechanisms. Moreover, the causes to the failure so far have been shared in parallel networks –a structural mechanism. Finally, templates to be used in future projects also have been designed to prevent the mistakes to reappear in the SkaS quality programme (Table 2). This also led to a second, successful project in the EW.

6.1. Cognitive learning mechanisms

Cognitive mechanisms provide language, concepts, models, values and theories for thinking, reasoning and understanding learning issues. Some examples would be models and approaches for improvement, company value statements but also strategy documents (Shani & Docherty 2008, 2003; Docherty & Shani, 2008). In this case, the analysis of the failed project revealed both the absence of reflection during the project, and also the negative impact of no reflective feedback being shared with and among co-workers at the actual workplace – the how-aspect of learning (Tucker et al. 2007). The lessons learned inspired us to redesign a) the SkaS quality system elucidating the importance of management commitment, and b) a revised Six Sigma roadmap –DMAIC, incorporating an 'L' for learning and reflection –DMAICL (see figure 2). In the Learning phase, the project manager and the members of the project group conjointly reflect on the project process in order to 'improve the improvement processes'. Moreover, the sixth phase adds important time to the delivery of the solutions in the daily operations of management; this was indicated by earlier Six Sigma project experiences. The DMAICL roadmap has been used in every black belt and green belt project at SkaS since 2006 and could thus be seen as an institutionalization of a learning mechanism throughout the organization (Crossan et al. 1999). The importance of iterations of the DMAICL- cycle has also been highlighted at SkaS.

Root causes of the failed project	**Solutions integrated into the SkaS quality programme**	**Type of learning mechanism**
1 Management knowledge of the importance of project communication and how this should be accomplished was lacking	a) Feedback to top management and a revision of the SkaS quality system highlighting the importance of management involvement b) Revised templates for the problem solving procedure	Cognitive, structural and procedural
2 Poor management knowledge of the importance of physically being involved and showing engagement in the project	Same as above	Cognitive, structural and procedural
3 Not enough focus on critical project stakeholder issues early on in the Six Sigma education	a) A stakeholder template was incorporated into the 'DMAICL' roadmap b) The importance of stakeholder involvement was elucidated in the Six Sigma education	Cognitive and procedural
4 The Six Sigma education was too compressed and did not contain other methods as well	Revision of the education; Lean and Design for Six Sigma were added to the Six Sigma education and the education was prolonged	Cognitive
5 The project mentor did not give enough support to the project managers in helping them delimiting the scope of the project but also in suggesting alternative methods	a) A revised problem solving procedure –DMAICL – was established b) Revised templates for delimiting projects	Cognitive and procedural
6 Poor communication between mentor and project managers	a) Accelerating learning through the establishment of parallel learning structures at SkaS b) Revised templates for project communication	Structural and procedural
7 Inexperienced project mentor and project managers	Same as above	Structural and procedural

Table 2. The integration of lessons learned from the failed project into the SkaS quality programme

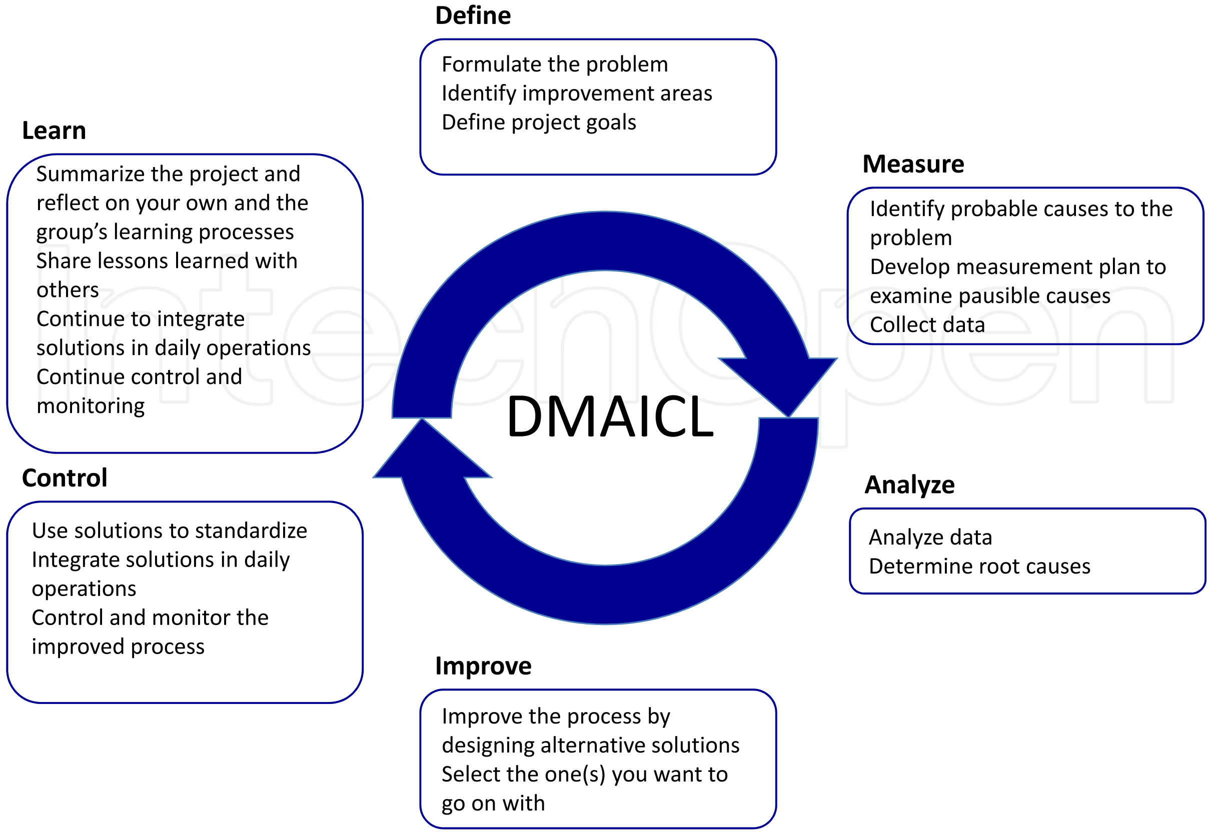

Figure 2. The improved DMAICL–cycle currently used at SkaS

6.2. Structural learning mechanisms

Structural mechanisms concern organizational, technical and physical infrastructures that enhance learning, e.g. different feedback and communication channels, arenas/forums and networks for dialogue, but also specific learning structures such as parallel learning structures.

As a result from the analysis of the actual project but also drawing from other parallel project experiences at SkaS (Lifvergren et al. 2010, 2008), horizontal permanent arenas for learning have been established. In these forums, project managers and quality coordinators from different organizational units meet every month to learn from improvement 'successes' and 'failures'. Improvement efforts are monitored and analyzed in order to learn how to improve the 'project process' itself. From these network activities, important learning is spread throughout the hospital; e.g. project groups and project mentors can learn from each other. Also, sharing the 'L' from every project inspires reflection and second loop learning between projects. Moreover, an intranet project database displaying concluded as well as ongoing and future improvement projects has been established.

A parallel learning structure has been instituted –integrating the selection and training of operational personnel to conduct the Six Sigma projects in operational units. Many return to their units, while others after further training, become internal consultants (cf. Bushe and Shani 1991).

6.3. Procedural learning mechanisms

Procedural mechanisms pertain to the rules, routines, procedures and methods that can be institutionalized in the organization to promote and support learning, e.g. assessment methods and standards (Docherty and Shani 2008; Shani and Docherty 2008). In this particular case, the cognitive and procedural mechanisms overlap, where roadmap templates to be used in every larger improvement project support the new cognitive model DMAICL (figure 2).

6.4. A second and successful retake on the project using learning mechanisms

The problem with long LoS persisted, so a new improvement project was initiated in 2008. Learning from the root cause analyses of the failed project, the clinical manager was deeply involved in the project, supporting it and requesting regular feedback on its progress; the project was subdivided in to several subprojects. Even more emphasis was put on continual and regular project communication to involve all co-workers at the EW. All these efforts are examples of *procedural* learning mechanisms. This resulted in several improvement suggestions from the front line staff. Moreover, expert knowledge on flow theory in daily operations was brought to the project – a *cognitive* learning mechanism. Much effort was also invested in involving and motivating the physicians. Finally, an improved DMAICL roadmap –signifying cognitive and procedural mechanisms –was followed (see figure 2). As a result of all these efforts, the project managed to reduce mean LoS at the EW by 20 minutes during 2008, an improvement that has been sustainable during 2009 and 2010.

7. Conclusions

In this chapter, we have described how a deeper analysis of a project that initially failed its client has led to emphasizing learning and integrating learning mechanisms into the SkaS Sigma programme, thus contributing to the present project success rate of 75% (Lifvergren et al. 2010).

In every improvement programme, the concept of Continual Improvement (CI) plays a vital role. At the core of CI, we find the learning cycles – PDSA, PDCA, DMAIC – critical to joint sensemaking (Weick 1995) and learning that creates actionable knowledge (Bradbury and Reason 2001, 2008). This particular project has disclosed how the importance of learning has been played down in the DMAIC roadmap in favor of more instrumentally emphasized problem solving techniques, e.g. templates, project charters and statistical analyses (Anthony et al. 2007; Schroeder et al. 2008). The experiences presented here have led to the addition of an 'L' in the roadmap, DMAICL, thus highlighting the original intentions of the learning cycles that somehow got lost on the way (Deming 1986; Shewhart 1939). We further propose that the 'L' might signify cognitive and procedural learning mechanisms, the intention of which is to invoke second loop learning within and between project groups and operational units.

Moreover, through the use of learning mechanisms, a design approach to institutionalization can be adopted (Crossan et al. 1999; Shani and Docherty 2003), including the contextual, historical and cultural factors present in every organization, while reducing the unpredictability of organizational change.

To openly show and analyze your failures adds knowledge and enhances a reflexive approach and a non-punitive culture in the organization. In that respect, the initially unsuccessful project could actually be considered to be the most successful project in SkaS Six Sigma programme, contributing to the how-aspects of learning (Tucker et al. 2007).

8. Further research

The challenges facing healthcare calls for sustainable changes, necessitating long term approaches. The integration of learning mechanisms in the change efforts taking place at SkaS but also in other healthcare organizations of the Western Region in Sweden will be followed continuously. How learning mechanisms are interpreted and adopted in other healthcare systems given their unique culture and history is also a question that deserves further investigation. Moreover, can learning mechanism be adopted to alleviate the conflicts that often emerge between vertical, hierarchical management structures *and* improvement projects that seek to solve problems pertaining to the value creating horizontal patient processes (Hellstrom et al. 2010)?

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Chapter 3

Project Costs and Risks Estimation Regarding Quality Management System Implementation

Adela-Eliza Dumitrascu and Anisor Nedelcu

Additional information is available at the end of the chapter

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1. Introduction

Project management is the art — because it requires the skills, tact and finesse to manage people, and science because it demands an in-depth knowledge of an assortment of technical tools, of managing relatively short-term efforts, having finite beginning and ending points, usually with a specific budget, and it must meet or exceed customers' needs and expectations (Duicu et al., 2011). This involves balancing competing demands among:

- Scope, time, cost and quality;
- Stakeholders with different needs and expectations;
- Identified requirements and expectations.

All projects share the same characteristic - the design ideas and transform them into new activities and achievements. Elements of risk and uncertainty always present show that the activities and tasks necessary to implement the projects may never be planned with absolute accuracy when very complex projects, the very possibility of their successful completion can sometimes be called into question. Project management follows the processes and guidelines established by the PMI, (2004).

Project management uses a set of principles, rules, expertise, methods and tools for planning, necessary to start the deployment and successful completion of a project. In addition, project management is a system based on: financial resources, human and time.

Within each phases of project development, there are many processes, which must be completed before a project can move into the next phase. Project Management Institute suggests that the five process control groups should be used to define these processes within each phase of a project for a successful implementation. Based on the classification of each project, different combinations of processes should be used to successfully complete the project. Some factors included in this measurement of classification include complexity of scope, risk, size, period, institutional experience, and access to resources, maturity, and industry and application area. The figure 1 provides an overview of the process groups that will be implemented in any phase of a project (ASU, 2012).

One of the key elements of the competitiveness is quality. Quality management is an essential component of the project management along with other processes. Growth and continuous improvement of performance of a project depends heavily on how to ensure proper management of quality. Quality of project management not only refers to time and budget, but to specification and quality requirements.

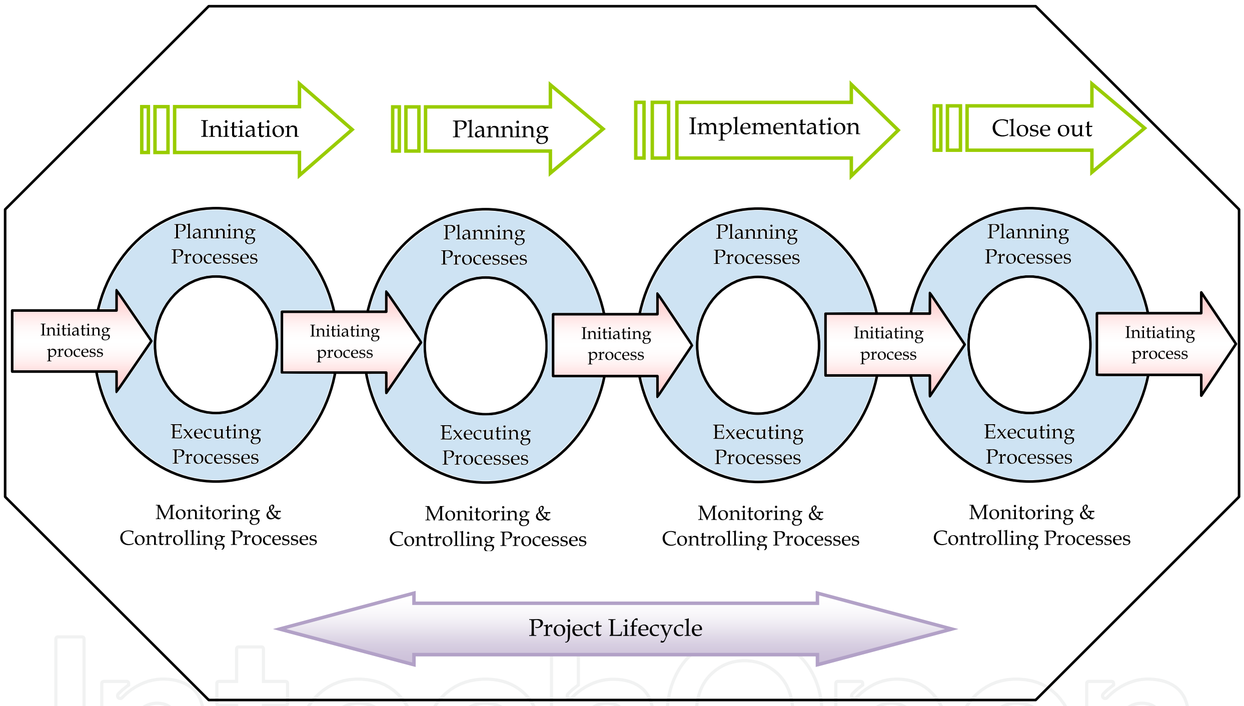

Figure 1. Project process groups

Project quality management consists of processes to ensure that the project will meet the requirements defined and planned, that quality planning processes, quality assurance and quality control (PMD, 2008).

Project quality management includes all management activities that will ensure the quality policy, objectives, and responsibilities and fulfill them through planning and improving quality through quality assurance and quality control. The project quality management processes are specified in figure 2.

Figure 2. Project quality management processes

Project quality management is the process required that ensures that the project meets requirements and expectations of the beneficiary involved in the project consists of: identification of relevant quality levels for the project and how to meet them, planned activities implemented quality system intended to ensure that the project will be within the parameters of quality planning, monitoring results of project activities and assessing their quality standards, ways to eliminate the causes which led to unsuccessful and continuous improvement (Nedelcu & Dumitrascu, 2010).

In figure 3 is illustrated an approach model of the quality management system in projects.

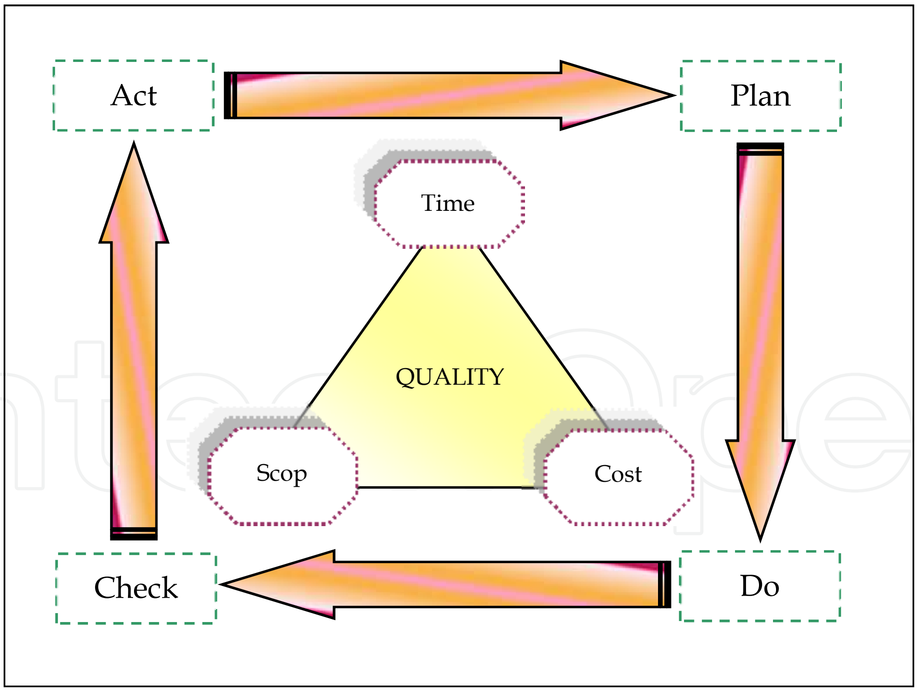

Figure 3. Project quality management

Quality management is a continuous process that starts and ends with the project. It is part of every project management processes from the moment the project initiates to the final steps in the project closure phase.

The purpose of quality management system is:

- To exclude possible errors in planning, coordination and all other phases;
- To ensure a controlled way that qualitative requirements on processes, approaches and products are respected at all stages;
- To find faults / errors as soon as possible, remove them and determine measures to avoid repeated mistakes;
- Check permanent measures to ensure quality and efficiency, the need to initiate corrective action;
- To determine and initiate corrective action / preventive measures.

2. Projects costs management

2.1. Theoretical aspects

Project cost management includes the processes involved in planning, estimating, budgeting, and controlling costs so that the project can be completed within the approved budget. The related knowledge area processes are (PMI, 2004):

- Cost estimating – developing an approximation of the costs of the resources needed to complete project activities;
- Cost budgeting – aggregating the estimated costs of individual activities or work packages to establish a cost baseline;
- Cost control – influencing the factors that create cost variances and controlling changes to the project budget.

According to the American Association of Cost Engineers, cost engineering is defined as that area of engineering practice where engineering judgment and experience are utilized in the application of scientific principles and techniques to the problem of cost estimation, cost control and profitability.

Project cost management is primarily concerned with the cost of the resources needed to complete schedule activities. Project cost management should also consider the effect of project decisions on the cost of using, maintaining, and supporting the product, service, or result of the project. Life-cycle costing, together with value engineering techniques, can improve decision-making and is used to reduce cost and execution time and to improve the quality and performance of the project deliverable. On some projects, especially ones of smaller scope, cost estimating and cost budgeting are so tightly linked that they are viewed as a single process that can be performed by a single person over a relatively short period of time. These processes are presented here as distinct processes because the tools and techniques for each are different. The ability to influence cost is greatest at the early stages of the project, and this is why early scope definition is critical (PMI, 2004).

The dependence between project cost management processes and project phases are detailed in table 1.

Process	Project phase	Key deliverables
Estimate costs	Planning	Activity cost estimates, Basis of estimates
Determine budget	Planning	Cost performance baseline
Control costs	Monitoring and controlling	Work performance measurements

Table 1. Processes and phases of project cost management

Project cost estimates are a key component of the planning process and provide a basis for key decisions. Cost estimate represents a prediction of quantities, cost, and/or price of resources required by the scope of an asset investment option, activity, or project. As a prediction, an estimate must address risks and uncertainties. Estimates are used primarily as inputs for budgeting, cost or value analysis, decision making in business, asset and project planning, or for project cost and schedule control processes. Cost estimates are determined using experience and calculating and forecasting the future cost of resources, methods, and management within a scheduled time frame (ISO, 2010).

An activity cost estimate is a quantitative assessment of the likely costs of the resources required to complete schedule activities. This type of estimate can be presented in summary form or in detail. Costs are estimated for all resources that are applied to the activity cost estimate. This includes, but is not limited to, labor, materials, equipment, services, facilities, information technology, and special categories such as an inflation allowance or cost contingency reserve.

The level of quality can be assessed with costs. It is normal for an organization to strive for the high quality products and services, but this procedure should not result in expenses that may cause, in turn, its bankruptcy. Thus, it is necessary to develop a budget for improving the quality and compared with expected profit. It is also necessary to establish special measures for sub-suppliers quality assurance, quality system continuously monitored, providing feedback information.

Data quality control is essential to ensure the integrity of results from quality improvements projects. Feasible methods are available and important to help to ensure that stakeholder's decisions are based on accurate data.

2.2. Costs estimation methods - modeling and simulation

Estimating the cost of project is one of the most crucial tasks for project managers. The main factors that are typically estimated at the beginning of a development project are: cost, size, schedule, quality, people resources, effort, resources, maintenance costs, and complexity. Cost estimation tools, or model-based estimation techniques use data collected from past projects combined with mathematical formulae to estimate project cost. They usually require factors such as the system size as inputs into the model.

The major software cost and schedule estimation techniques can be grouped and classified as regression-based models, learning-oriented models, expert based approaches and finally composite-Bayesian methods (Keaveney & Conboy, 2011). Therefore, there is a natural erroneous tendency associated with any form of estimation primarily because “an estimate is a probabilistic assessment of a future condition” and accuracy can therefore rarely be expected in the estimation process (Stamelos & Angelis, 2001). The causes of inaccurate estimates in development projects were grouped into four categories by Lederer & Prasad (1995), namely methodology, politics, user communication and management control.

A project simulation uses a model that translates the uncertainties specified at a detailed level of the project into their potential impact on project objectives. Simulations are typically performed using the Monte-Carlo technique.

In Monte-Carlo method calculations are repeated several times using the same, deterministic model of a physical phenomenon, but each time for different, randomly selected values of particular arguments, from among uncertainty range given a priori.

In a simulation, the project model is computed many times (iterated), with the input values randomized from a probability distribution function (e.g., cost of project elements or duration of schedule activities) chosen for each iteration from the probability distributions of each variable. A probability distribution (e.g., total cost or completion date) is calculated.

The Monte-Carlo technique is a device for modeling and simulating processes that involve chance variable. Monte-Carlo simulation requires hundreds or thousands of iterations. Each sample yields one possible outcome for the variable(s) of interest. By studying the distributions of results, we can see the range of possible outcomes and the most likely results. Using simulation, a deterministic value can become a stochastic variable. We can then study the impact of changes in the variable on the rest of the spreadsheet.

One of the most used distributions is the triangular because the input data can be obtained very easily and it does not require laborious investigations. Recent popularity of the triangular distribution can be attributed to its use in Monte Carlo simulation modeling and its use in standard uncertainty analysis software. The triangular distribution is also found in cases where two uniformly distributed errors with the same mean and bounding limits are combined linearly (Castrup, 2009).

Uncertainties may be modeled by the distribution where Johnson and Kotz (1999) discuss the asymmetric triangular distribution. Suppose that:

$$x_i = \begin{cases} a + \sqrt{z_i \cdot (b-a) \cdot (m-a)}, a < x_i \le m \\ b - \sqrt{(1-z_i) \cdot (b-a) \cdot (b-m)}, m < x_i \le b \end{cases}, \qquad (1)$$

where $\hat{a}$ is lower estimate, $\hat{m}$ is most likely estimate value and $\hat{b}$ is maximum estimate value.

The mean and standard deviation are given by:

$$\mu = \frac{a+m+b}{3}, \qquad (2)$$

$$\sigma = \sqrt{\frac{a^2 + m^2 + b^2 - am - ab - mb}{18}} . \quad (3)$$

The distribution emerges in numerous papers (Mohan et. al, 2007; Keefer & Verdini, 1993) and the probability density function for asymmetric three-parameter is given by:

$$f(x) = \begin{cases} \frac{2(x-a)}{(b-a)\cdot(m-a)}, a < x \le m \\ \frac{2(b-x)}{(b-a)\cdot(b-m)}, m < x < b \\ 0, elsewhere \end{cases} . \quad (4)$$

Cumulative distribution function is defined by:

$$F(x) = \begin{cases} 0, x \le a \\ \frac{(x-a)^2}{(b-a)\cdot(m-a)}, a < x \le m \\ 1 - \frac{(b-x)}{(b-a)\cdot(b-m)}, m < x < b \\ 1, x \ge b \end{cases} . \quad (5)$$

Cumulative distributions functions are usually presented graphically in the form of ogives, where we plot the cumulative frequencies at the class boundaries. The resulting points are connected by means of straight lines, as shown in chapter 2.3.

If the relative frequency is plotted on normal probability graph paper the ogive will be a straight line for a normally distributed random variable. The normal probability graph paper is a useful device for checking whether the observations come from a normally distributed population, but such a device is approximate. One usually rejects normality when remarkable departure from linearity is quite evident (Gibra, 1973).

2.3. Case study regarding project cost estimation of the quality management system implementation

Implementation of a quality management system (QMS) takes a lot of time and effort, whereas the top management wants benefits on a short period of time. The purpose of this case study is to provide the applicative aspects of project costs estimation of a QMS implementation.

The specific objectives achieved by this project are:

- Correct identification of processes within the organization;

- Development of specific documents of the QMS (quality manual, documented procedures of quality management system, specific documents);
- Implementation and certification of QMS according to ISO 9001:2008 accredited by a recognized certification organization in order to increase the performances of the own organization.

Quality management system implementation aims:

- Ongoing activities to meet customers' expectations;
- Products comply with applicable standards or specifications;
- Products offered at competitive prices;
- Products obtained in terms of profit.

The profit can be obtained by applying a rigorous prediction of specific costs. There plays a significant role the application of efficient and effective cost management. The project must be within allocated budget. Competitiveness of products and services is linked to quality. To achieve the objectives is not sufficient to implement the various techniques and methods, but quality must be acknowledged and implemented in all fields and at all levels. All these are possible only by introducing and supporting the documentation of quality management system.

Quality management system will assist by:

- Managing costs and risks;
- Increasing effectiveness and productivity;
- Identifying improvement opportunities;
- Increasing customer satisfaction.

A well-managed quality system will have an impact on:

- Customer loyalty and repeat business;
- Market share and industry reputation;
- Operational efficiencies;
- Flexibility and ability to respond to market opportunities;
- Effective and efficient use of resources;
- Cost reductions and competitive advantages;
- Participation and motivation of human resources;
- Control on all processes within organization.

Project quality evaluation represents an essential component of project success. The implementing process of a quality management system in an organization may be considered as a project. The general objective of this project is implementation, maintaining, certification and continuous improvement of the quality management system in organization in accordance with ISO 9001:2008. Therefore, in figure 4 are detailed the phases within a project's lifecycle and it will be considered complete and operational.

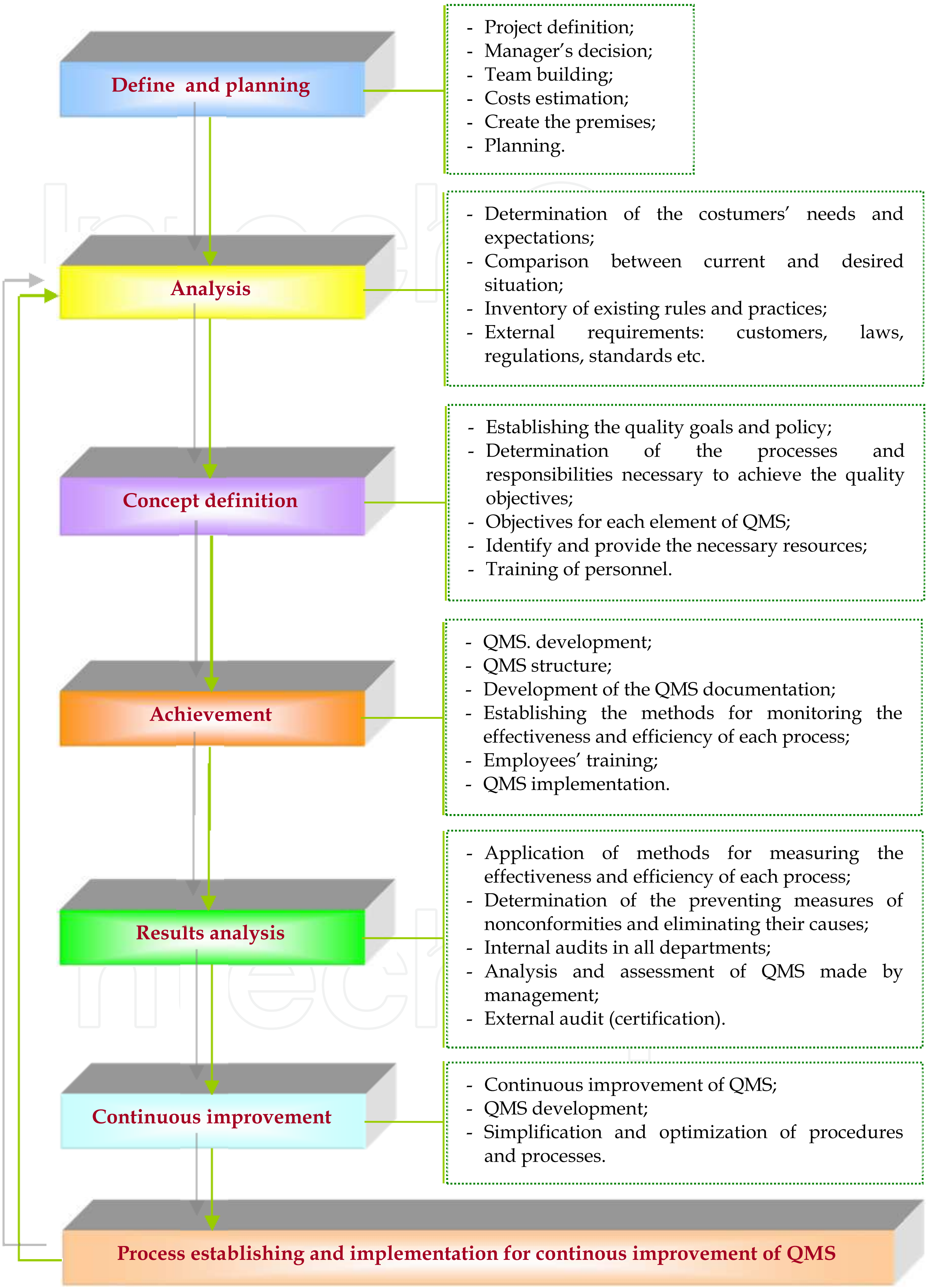

Figure 4. Project phases of a quality management system implementation

The applicative researches focuses on the relevant activities related to the QMS implementation and it covers the following stages:

- Diagnostic audit according to ISO 9001:2008 requirements;
- Establishing the quality policy and goals;
- Establishment of quality management program;
- Training of top management team;
- Initial evaluation, processes planning and identification relevant to quality system;
- Development of the quality management system documents;
- Approval, multiplication and dissemination of quality management system documents;
- Implementation of quality management system;
- Documentation for certification of quality management system;
- Preliminary discussion with selected accredited (optional);
- Internal quality audit;
- Transmission the documents of quality management system to certification organization (quality manual, procedures, work instructions);
- Reviewing the documentations by certification organization;
- Audit plan;
- Certification audit;
- Surveillance audit (annual);
- Recertification audit (three years).

For the most important tasks that imply substantial costs for QMS implementation process it was performed the simulated researches of the project activities costs using triangular distribution. The analyzed activities are presented in figure 5.

Figure 5. Main stages of quality management system implementation specific to costs simulation process

To estimate the cost of an activity we need to know how long it can run, that human or material resources will be involved, raw materials and materials used in the execution of activities. Consequently, the estimation process in a project must start from the estimation times. To do this, we can assess the effort required to execute each task.

Considering the steps of quality management system implementation described above, the Monte-Carlo simulation program is detailed in figure 6.

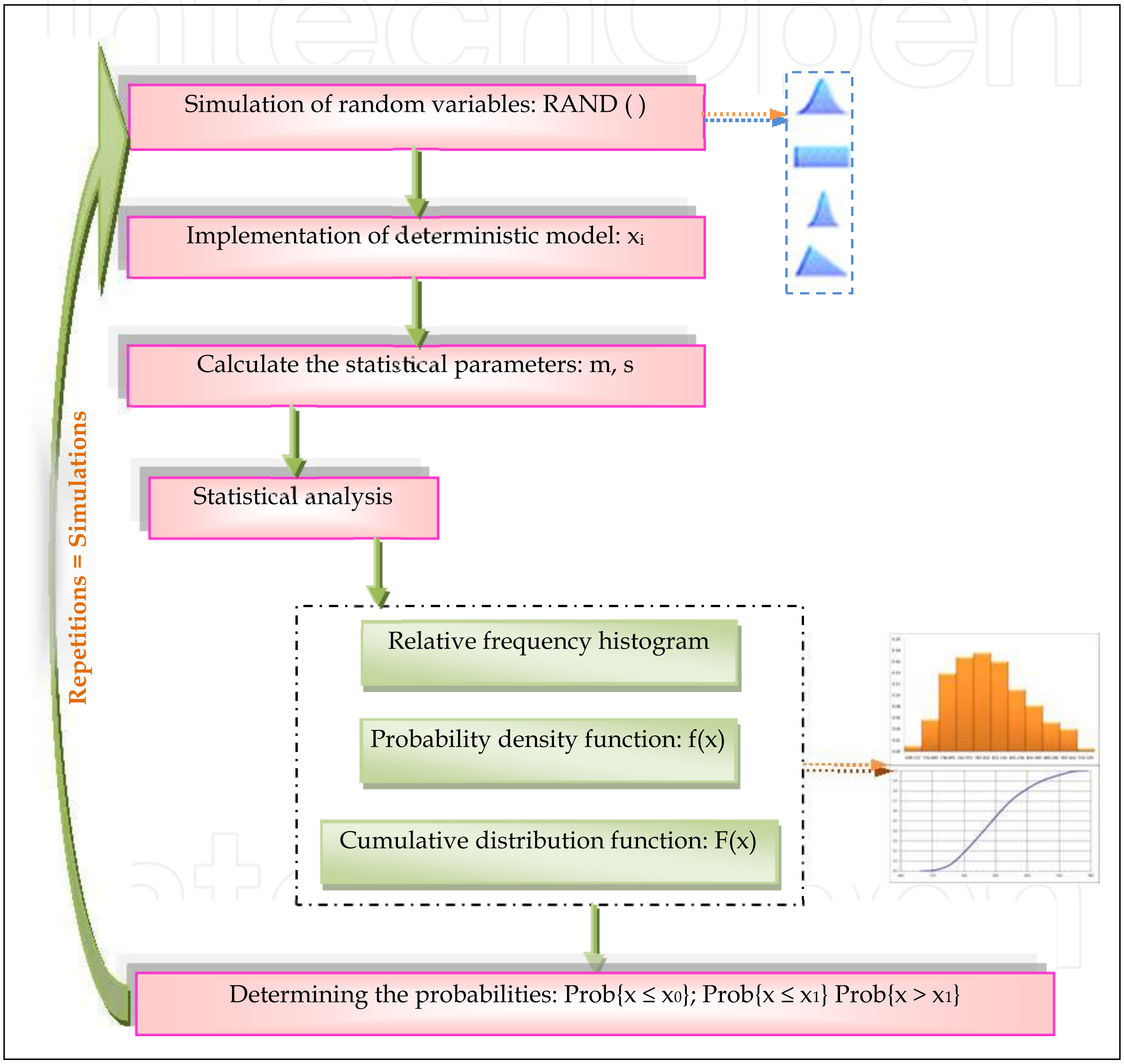

Figure 6. Monte-Carlo simulation program

Excel is not optimized for statistics, so other vendors have created add-ins offering more features. They not only calculate probabilities, but also permit Monte Carlo simulation to draw repeated samples from a distribution.

Consider an outcome, such as the task cost and we want to simulate what the actual costs might be if we know the lowest cost, the highest and the most likely. As a result, the simulation of specific costs for analyzed activities are represented by relative frequency histograms (see figure 7, figure 9, figure 11, figure 13, figure 15, figure 17, figure 19). If we run a stochastically simulation on these tasks costs, it can construct a relative cumulative frequency graph (ogive chart) for these data and looks like in figure 8, figure 10, figure 12, figure 14, figure 16, figure 18, figure 20). Cumulative distribution curve indicates the probability that we will complete this project tasks in less cost than the deterministically predicted. Each time the simulation is executed, the cell will be updated to show a random value drawn from the specified distribution.

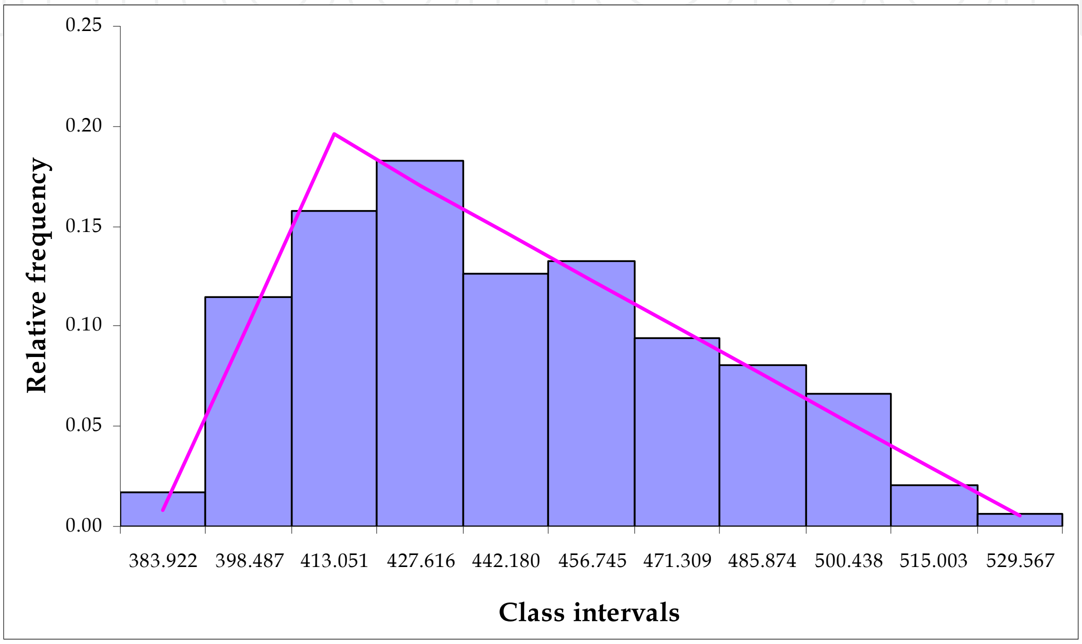

Figure 7. Relative frequency histogram for task 1

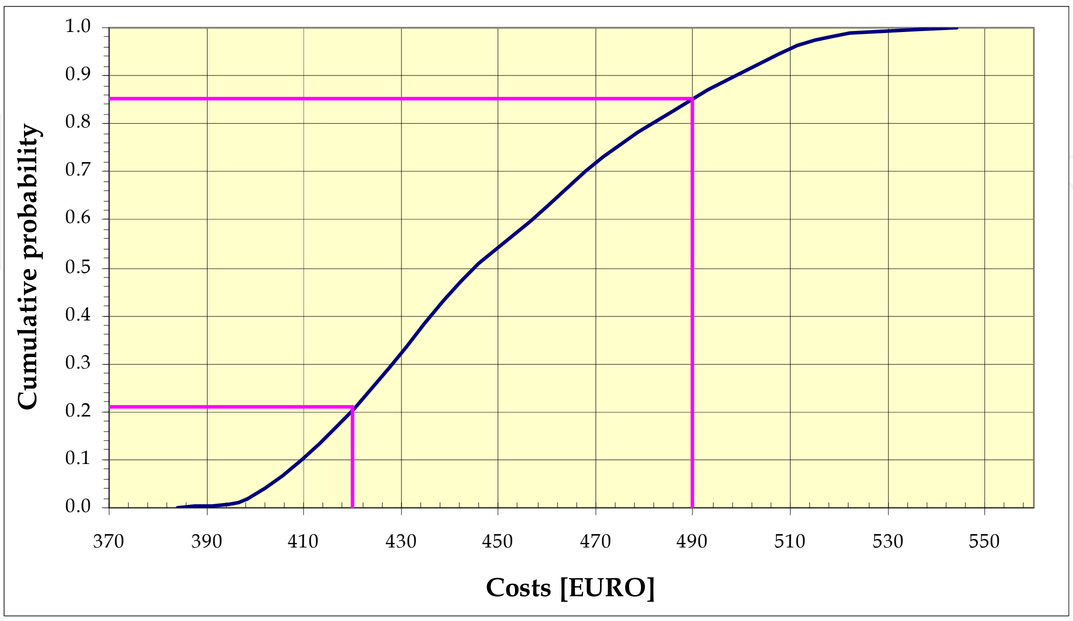

Figure 8. Cumulative frequency distribution for task 1

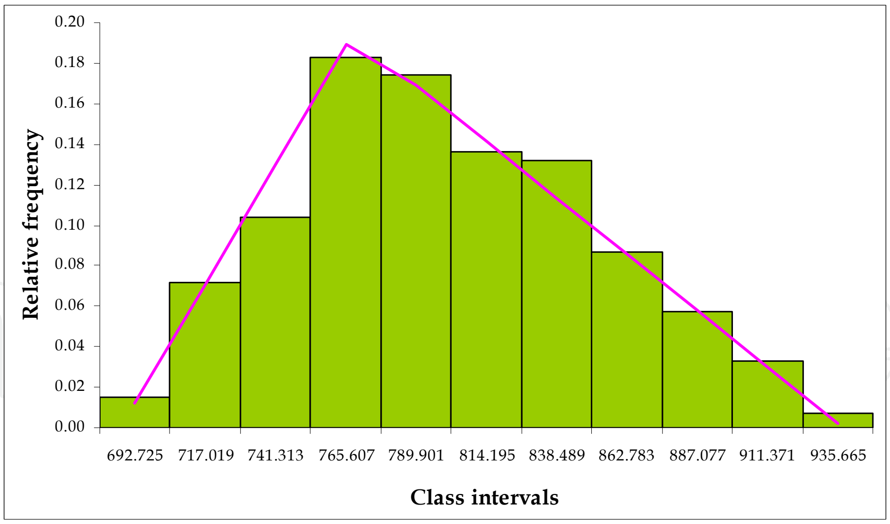

Figure 9. Relative frequency histogram for task 2

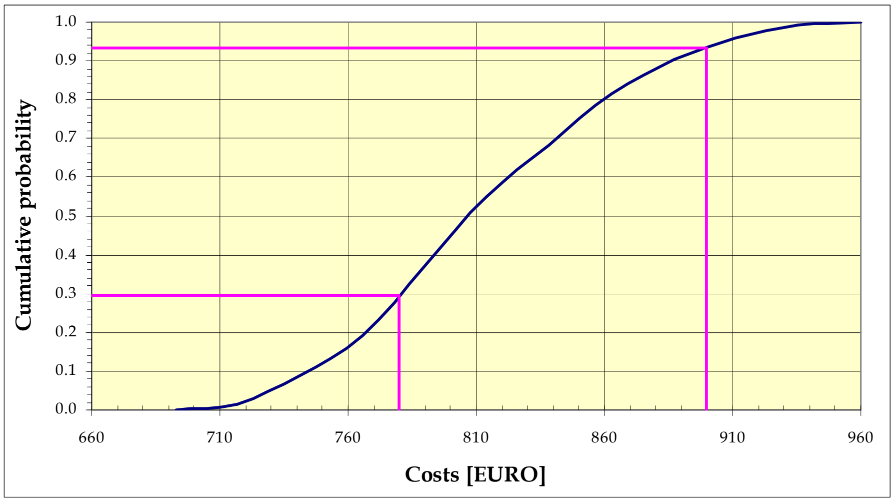

Figure 10. Cumulative frequency distribution for task 2

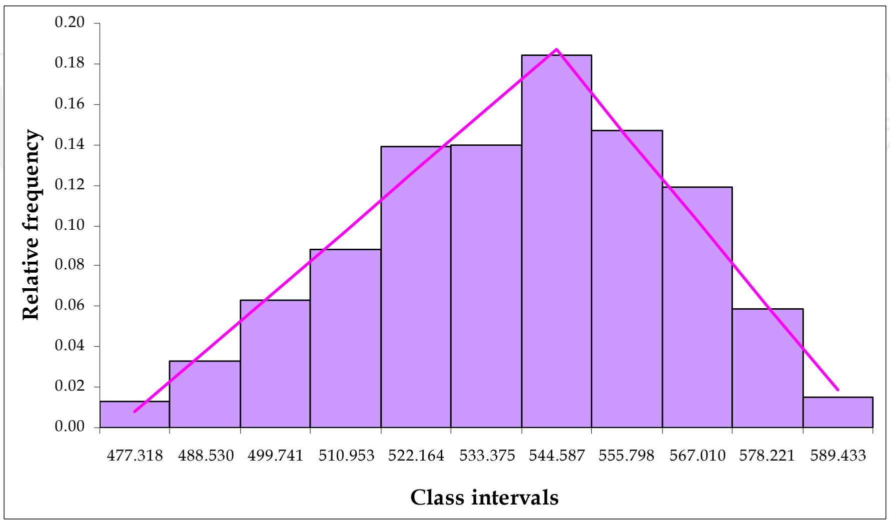

Figure 11. Relative frequency histogram for task 3

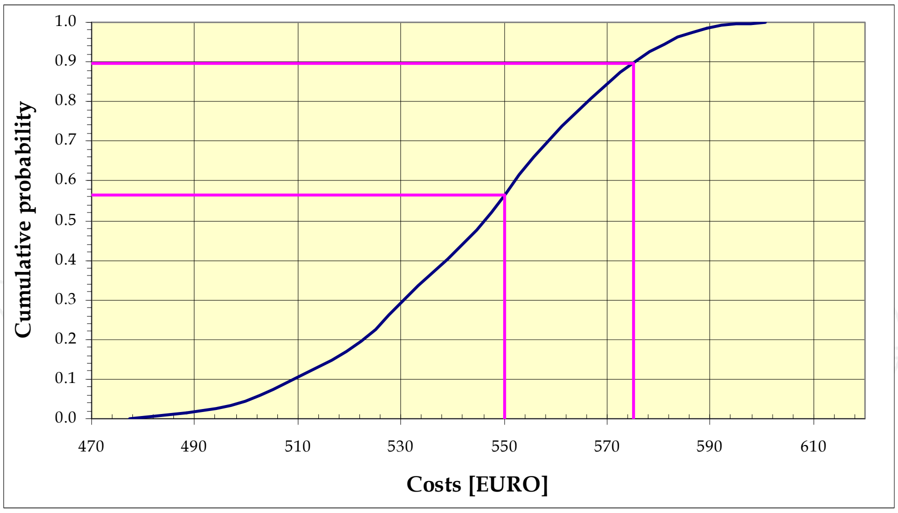

Figure 12. Cumulative frequency distribution for task 3

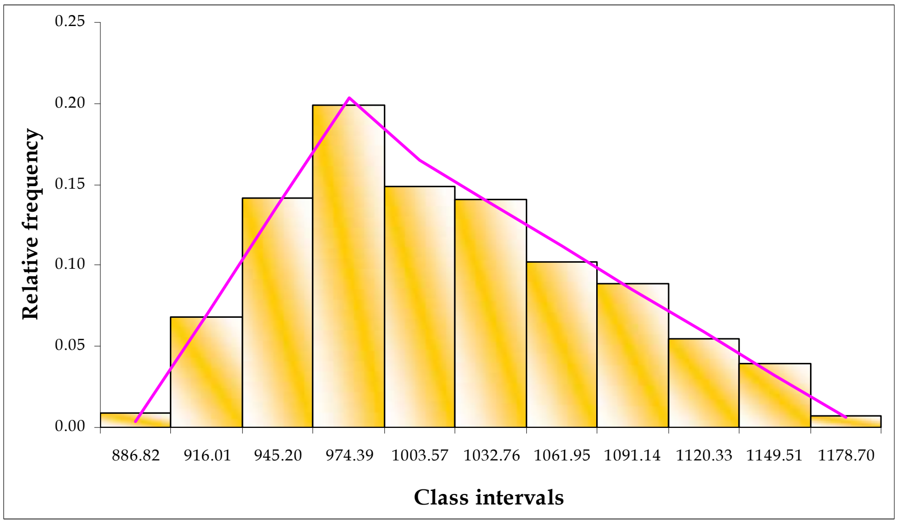

Figure 13. Relative frequency histogram for task 4

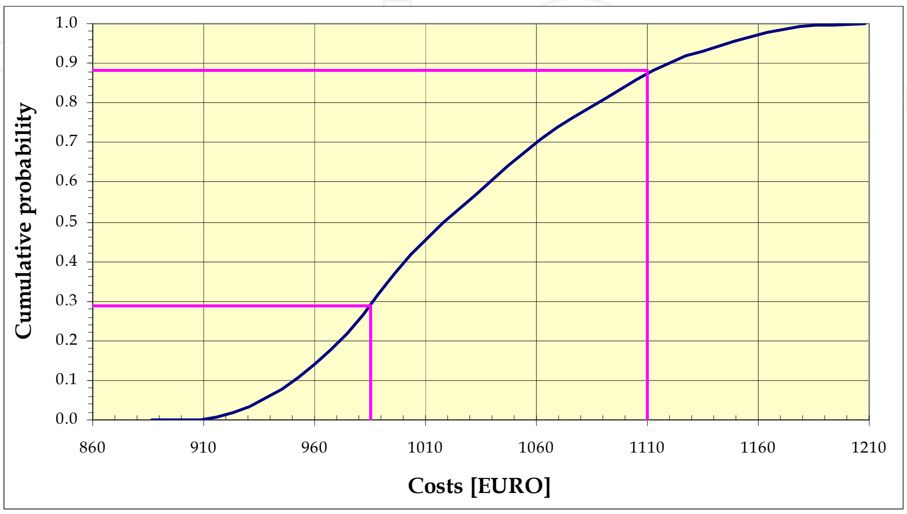

Figure 14. Cumulative frequency distribution for task 4

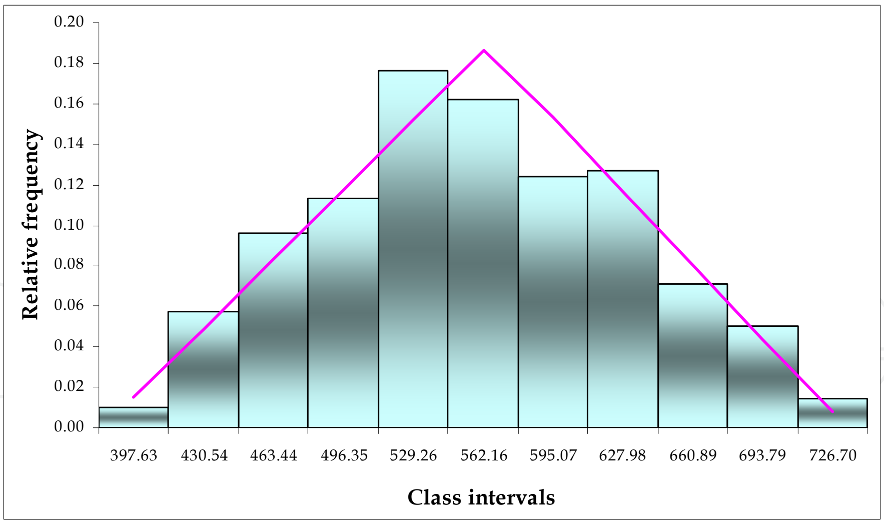

Figure 15. Relative frequency histogram for task 5

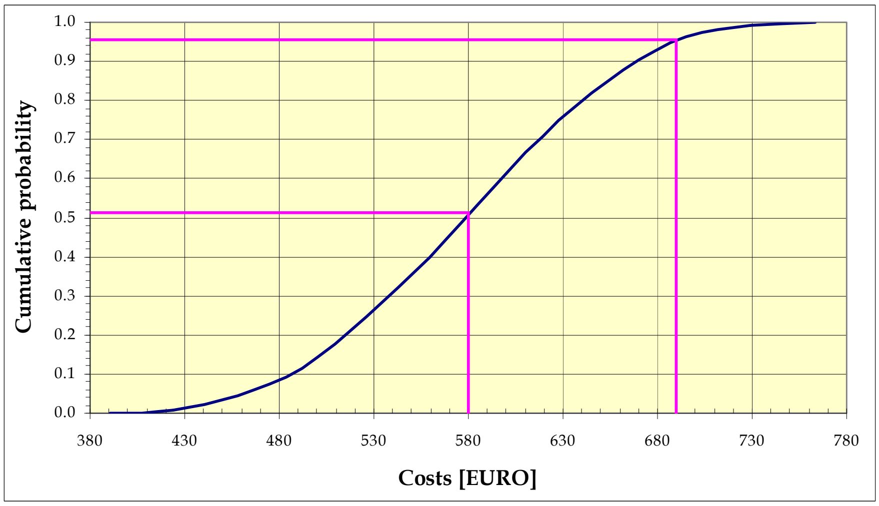

Figure 16. Cumulative frequency distribution for task 5

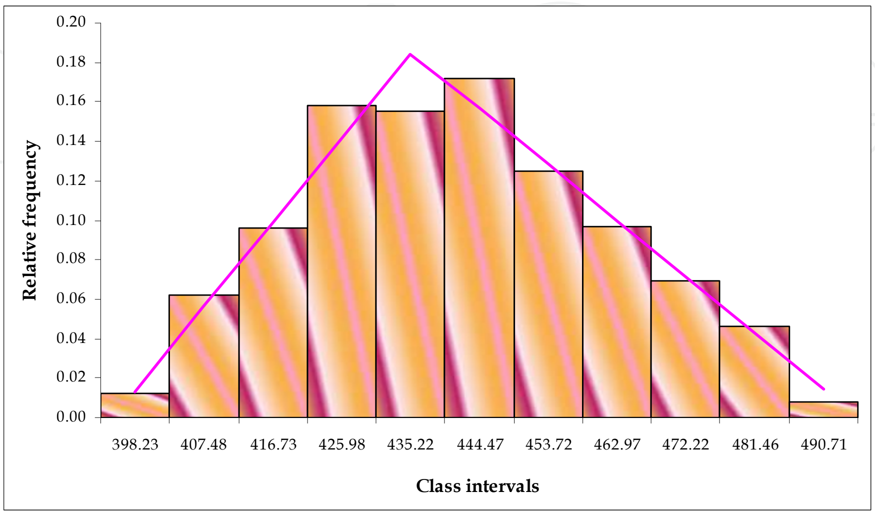

Figure 17. Relative frequency histogram for task 6

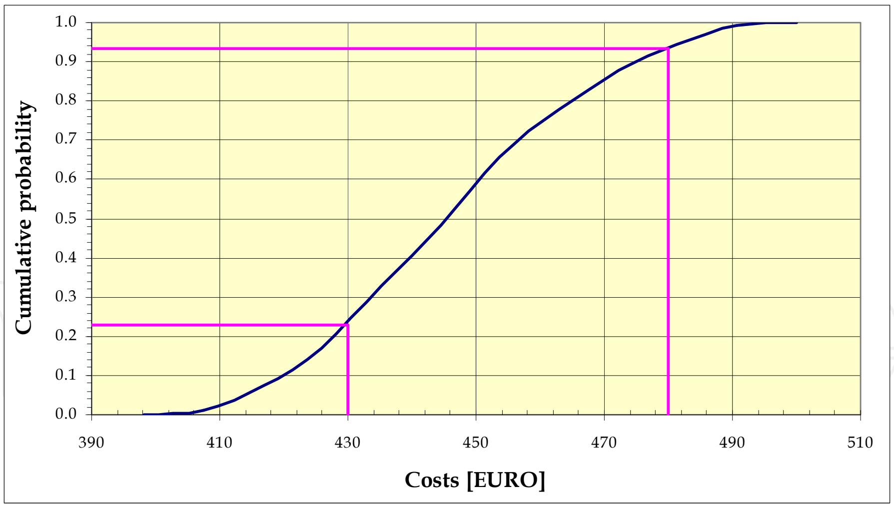

Figure 18. Cumulative frequency distribution for task 6

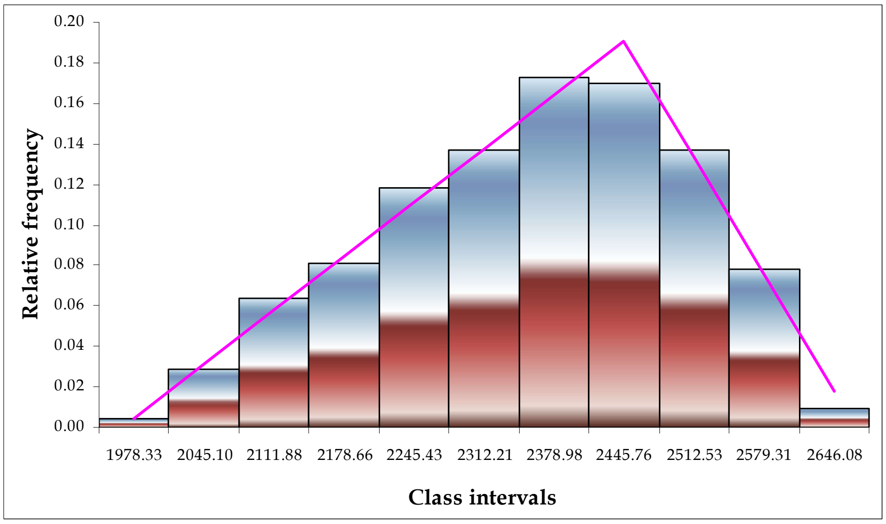

Figure 19. Relative frequency histogram for task 7

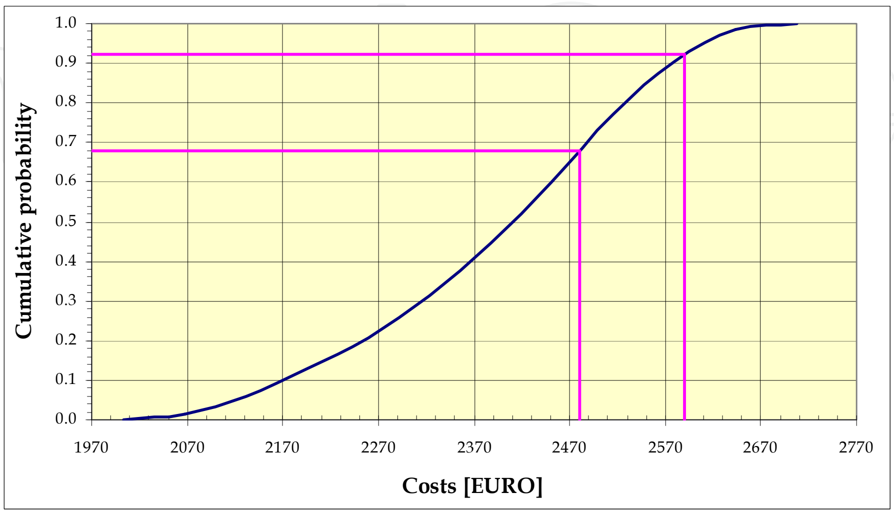

Figure 20. Cumulative frequency distribution for task 7

In table 2 are detailed the input data and the results of simulation process. It can be observed that the probability to exceed the maximum allocated costs of the tasks is smaller than 14%. Taking into account the contingency funds for the overall project tasks (approximately 10-20%), we will be able to accomplish the project activities with the planned costs and time.

Tasks	Minimum	Likely	Maximum	Prob$\{x \leq x_0\}$	Prob$\{x \leq x_1\}$	Prob$\{x > x_1\}$
Activity 1	390	420	550	0.212	0.863	0.137
Activity 2	700	780	950	0.292	0.937	0.063
Activity 3	400	550	600	0.561	0.891	0.109
Activity 4	900	985	1200	0.283	0.864	0.136
Activity 5	400	580	750	0.514	0.956	0.044
Activity 6	400	440	500	0.226	0.926	0.074
Activity 7	2000	2480	2700	0.679	0.923	0.077

Table 2. Simulation process results

Analyzing the relative frequency histograms, it can be seen the standard asymmetric triangular distribution. For activities where the distribution is skewed to the left, we might finish the tasks ahead of schedule and for the distribution is skewed to the right, the project implies supplementary costs.

3. Projects quality improvement through risks management process

Management of risk is an integral part of good business practice and quality management. Learning how to manage risk effectively enables managers to improve outcomes by identifying and analyzing the wider range of issues and providing a systematic way to make informed decisions. A structured risk management approach also enhances and encourages the identification of greater opportunities for continuous improvement through innovation (AUSAID, 2006).

Project risk management offers a great opportunity to improve project performance dramatically. The amount of work needed to implement the project risk management process is considerably less than that devoted to other project variables such as cost, schedule, or quality, yet the benefits are equally great. The greatest challenge to implementing a project risk management lies in changing corporate culture. However, once this is done, and risk management becomes routine, it will add greatly to the probability of project success (Naughton, 2012).

To be competitive, an organization must be proactive in managing the risks to successful achievement of the cost and schedule objectives for its projects. The risks management implementation can improve the quality of supplied products and processes through the identification, monitoring and control of risks.

3.1. Concepts, principles and components of risks management

Project risk represents uncertain events or situations that potentially can adversely affect a project as planned, usually in terms of cost, schedule, and/or product quality.

Project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project; most of these processes are updated throughout the project (PMI, 2004). It involves processes, tools, and techniques that will help the project manager to maximize the likelihood and consequences of positive events and minimize the probability and consequences of adverse events. In figure 21 it is shown the processes of project risk management.

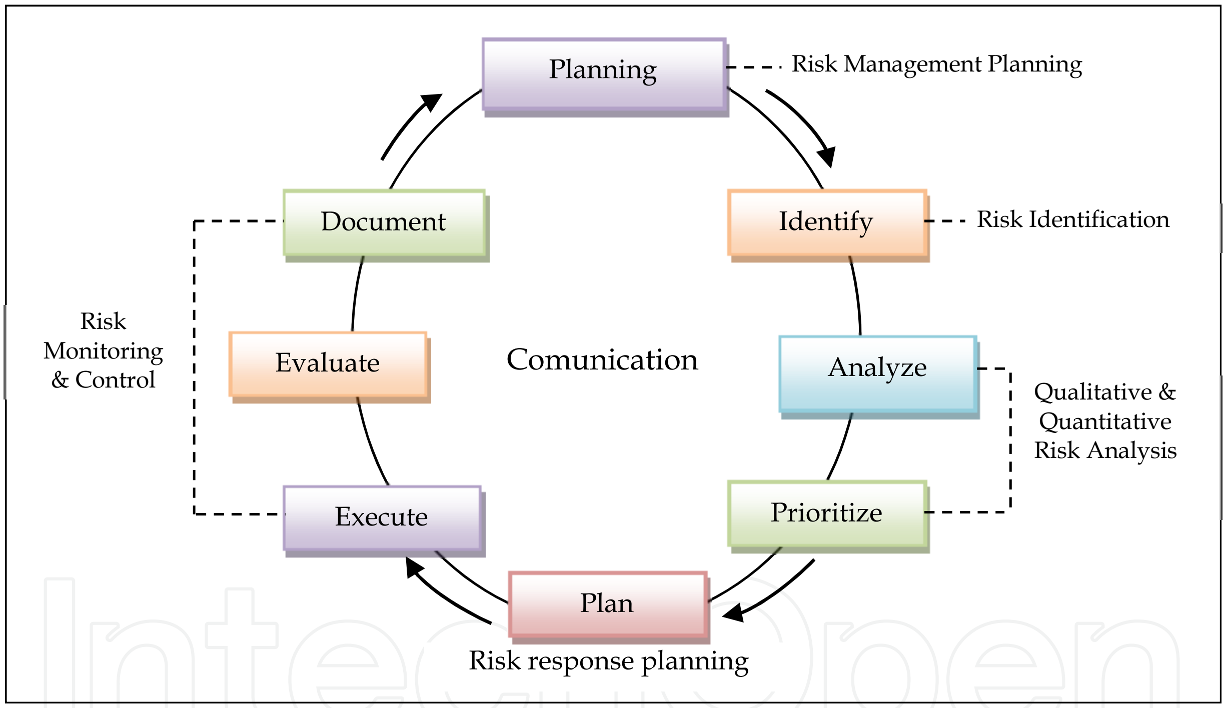

Figure 21. Project risk management process

Risks are prioritized according to their potential implications for meeting the project's objectives. A risk matrix is used to combine likelihood and impact ratings values to obtain a risk score. The risk score may be used to aid decision making and help in deciding what action to take in view of the overall risk. How the risk score is derived can be seen from the sample risk matrix shown in table 3. The organization can define as many risk levels as it believe are necessary. In our case the matrix presents tree domains: high, moderate and low risks.

Probability					
0.90	0.05	0.09	0.18	0.36	0.72
0.70	0.04	0.07	0.14	0.28	0.56
0.50	0.03	0.05	0.10	0.20	0.40
0.30	0.02	0.03	0.06	0.12	0.24
0.10	0.01	0.01	0.02	0.04	0.08
	0.05	0.10	0.20	0.40	0.80
Impact					

Table 3. Risk assessment with risk matrix

3.2. Risks estimation of quality management system implementation

Risk management for implementing a QMS consists of dealing with big and small objections, coming from people all over the organization, and can, in general, not be quantified in the same way as the risks in a production process (CERCO, 2000).

Risk management is a facet of quality, using basic techniques of analysis and measurement to ensure that risks are properly identified, classified, and managed.

The main objectives of this case study are:

- Identification and definition of risks categories;
- Establishing the criteria (factors) of risks analysis and their levels of assessment;
- Determining the risk score;
- Risk ranking in three categories: high, medium or small level;
- Risks prioritization and implement the corrective or preventive actions.

3.2.1. Risks Identification

It is evaluate the potential risks to the opportunity, to be able to build a project plan that maximizes the probability of project success. Risk identification is generally done as part of a feasibility study, at the beginning of the active project work, and at each new phase of a large project.

The project team considers:

- Risks: what might go wrong;
- Opportunities: better methods of achieving the project's purpose and need;
- Triggers: symptoms and warning signs that indicate whether each risk is likely to occur.

After the assessment, risk categories that influence the project development of the quality management system implementation are detailed in table 4.

Risks categories	**Risk description**
Quality risk	Risk that influence product quality or service supplied
Project management risk	Risk which influence development of the project due to the planning process.
Internal risk	Risk influencing the project development caused internal factors of the organization
External risk	Risk affecting the whole system caused by the changes of external entities (importers, laws, authorizations, etc.)
Financial risk	Risk that affects the allocated budget

Table 4. Identified risks categories

3.2.2. Qualitative analysis

In this step are assessed the impacts of identified risks (table 5).

No.	Risks categories	Risk impact (I)	Risk impact evaluation
R1	Choosing a consulting organization that does not know / not to meet the requirements of field / organization	0.8	Major impact (catastrophic) on the project, such as deviations more than 25% from the project scope, schedule or budget
R2	Exceeding the budget	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R3	Exceeding allotted	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R4	Wrong identification of processes	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R5	Omission of the stages in the description of processes	0.2	Measurable impact on the project, such as deviations of 5-10% from the project scope, schedule or budget
R6	There are not evaluated all departments	0.2	Measurable impact on the project, such as deviations of 5-10% from the project scope, schedule or budget
R7	Incomplete planning of processes / products	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R8	Documentation is incomplete	0.1	Minor impact on the project, such as deviations less than 5% from the project scope, schedule or budget
R9	Evaluation is not real	0.1	Minor impact on the project, such as deviations less than 5% from the project scope, schedule or budget

R10	Documentation is imposed without discussed	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R11	Do not have "client" in center of processes	0.2	Measurable impact on the project, such as deviations of 5-10% from the project scope, schedule or budget
R12	Do not reflect the commitment for customer satisfaction	0.2	Measurable impact on the project, such as deviations of 5- 0% from the project scope, schedule or budget
R13	Establishment of unrealistic targets	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R14	It does not comply with annual audit plan	0.1	Minor impact on the project, such as deviations less than 5% from the project scope, schedule or budget
R15	Audits weren’t done	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R16	Audits only formally	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R17	Unsolved of the prepared nonconformities report	0.05	Insignificant impact on the project. It is not possible to quantify the impact, which is extremely low.
R18	Decisions weren’t fulfilled	0.1	Minor impact on the project, such as deviations less than 5% from the project scope, schedule or budget
R19	Resumption of process if it is found that implementation was not effective	0.8	Major impact (catastrophic) on the project, such as deviations more than 25% from the project scope, schedule or budget
R20	Audit report to be prepared superficially	0.1	Minor impact on the project, such as deviations less than 5% from the project scope, schedule or budget
R21	Incomplete documentation and the certification process extension	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R22	Delay to transmission of the audit plan	0.1	Minor impact on the project, such as deviations less than 5% from the project scope, schedule or budget
R23	Identification of major nonconformities	0.4	Significant impact on the project, such as deviations of 10-25% from the project scope, schedule or budget
R24	Isn’t taken certification after audit	0.8	Major impact (catastrophic) on the project, such as deviations more than 25% from the project scope, schedule or budget

Table 5. Qualitative analysis of risks

3.2.3. Quantitative analysis

This process aims to analyze numerically the probability of each risk and consequences on project objectives (table 6).

No.	Risks categories	Likelihood (P)	Impact consequences
R1	Choosing a consulting organization that does not know / not to meet the requirements of field / organization	0.1	Certification is not obtained
R2	Exceeding the budget	0.9	More expenses than was anticipated
R3	Exceeding allotted	0.5	Financial losses and low productivity
R4	Wrong identification of processes	0.3	Delay to finish the project
R5	Omission of the stages in the description of processes	0.5	Delay to finish the project
R6	There are not evaluated all departments	0.5	There are not included all aspects
R7	Incomplete planning of processes / products	0.9	Delay to finish the project
R8	Documentation is incomplete	0.9	Delay to finish the project
R9	Evaluation is not real	0.7	Measures plans are not effective
R10	Documentation is imposed without discussed	0.7	Delay to finish the project
R11	Do not have "client" in center of processes	0.3	Delay to finish the project
R12	Do not reflect the commitment for customer satisfaction	0.3	Delay to finish the project
R13	Establishment of unrealistic targets	0.3	Delay to finish the project
R14	It does not comply with annual audit plan	0.7	Delay to finish the project
R15	Audits weren't done	0.1	Delay to finish the project / Certification is not obtained
R16	Audits only formally	0.1	Delay to finish the project / Certification is not obtained
R17	Unsolved of the prepared nonconformities report	0.3	Resumption of internal audits
R18	Decisions weren't fulfilled	0.3	Delay to finish the project
R19	Resumption of process if it is found that implementation was not effective	0.1	Delay to finish the project / Certificate wasn't taken at scheduled time
R20	Audit report to be prepared superficially	0.7	Certification is not obtained
R21	Incomplete documentation and the certification process extension	0.5	Delay to finish the project
R22	Delay to transmission of the audit plan	0.3	Delay to finish the project
R23	Identification of major nonconformities	0.5	Delay to finish the project
R24	Isn't taken certification after audit	0.3	Delay to finish the project

Table 6. Quantitative analysis of risks

3.2.4. Monitoring and control of risks

This stage supposes keeping track of identified risks, monitoring residual risks, and identifying new risks.

In table 7 are quantify the identified risks based on the risk matrix specified in table 3.

No.	Risks categories	Risk score (I x P)
R1	Choosing a consulting organization that does not know / not to meet the requirements of field / organization	0.08
R2	Exceeding the budget	0.36
R3	Exceeding allotted	0.20
R4	Wrong identification of processes	0.12
R5	Omission of the stages in the description of processes	0.10
R6	There are not evaluated all departments	0.10
R7	Incomplete planning of processes / products	0.36
R8	Documentation is incomplete	0.09
R9	Evaluation is not real	0.07
R10	Documentation is imposed without discussed	0.28
R11	Do not have "client" in center of processes	0.06
R12	Do not reflect the commitment for customer satisfaction	0.06
R13	Establishment of unrealistic targets	0.12
R14	It does not comply with annual audit plan	0.07
R15	Audits weren't done	0.04
R16	Audits only formally	0.04
R17	Unsolved of the prepared nonconformities report	0.015
R18	Decisions weren't fulfilled	0.03
R19	Resumption of process if it is found that implementation was not effective	0.08
R20	Audit report to be prepared superficially	0.07
R21	Incomplete documentation and the certification process extension	0.20
R22	Delay to transmission of the audit plan	0.03
R23	Identification of major nonconformities	0.20
R24	Isn't taken certification after audit	0.24

Table 7. Risks score

The identified risks are categorized by degrees of probability and impact, and they are distributed into high, moderate, and low risk categories.

After making analysis were results twenty-four risks for all stages of project development of a quality management system implementation. The most important risks that must be treated it can be seen in figure 22.

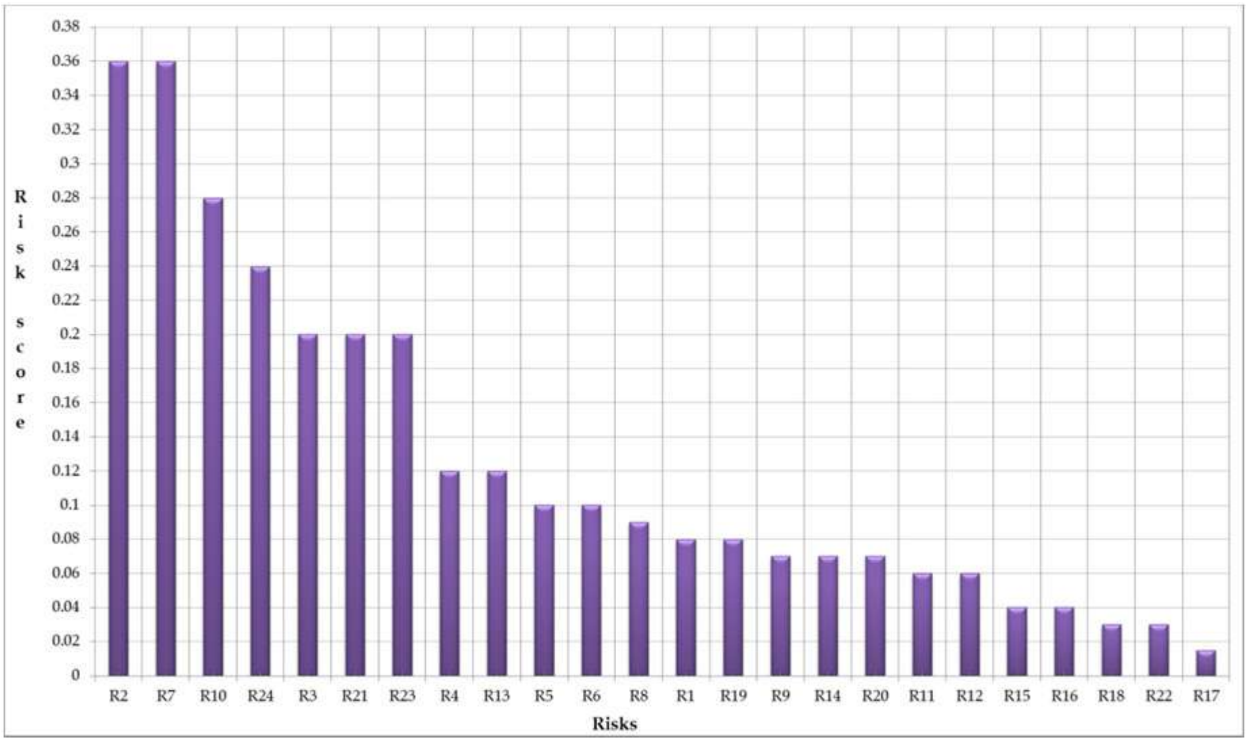

Figure 22. Risks prioritization

Also, implementing the monitoring and control plans, the risks situated in the high domain can be eliminated or minimized to a medium or low level.

Nothing can be controlled which cannot be measured. In a project there are three things which can always be measured - the schedule, the cost, and the users' satisfaction. If the project meets all these three criteria, it is right to consider it a successful project. If it meets two of them and comes close to the third it is probably successful. Few projects which are very late and very much over budget are considered to be successful and they meet the users' requirements. Therefore, the essence of risk management is the avoidance of anything which extends the schedule, increases the costs, or impairs the users' satisfaction with the product of the project.

4. Conclusions

Customer satisfaction provides valuable information for saving resources by tuning those processes and its quality aspects. Therefore the measurement of customer's satisfaction should be seen as an essential part of business management and should be carefully designed as one of the key measures of the success of an organization.

Monitoring quality costs is essential when implementing a quality management system as this gives relevant information about the balance between efforts and investments in quality to reduce non quality and what remaining non quality still costs. However it is difficult to identify all the relevant elements and the quality indicators are necessary because they provide a concrete tool to measure how the QMS is improving the organization's efficiency and effectiveness (CERCO, 2000).

The case study regarding costs estimation can be extending to the stochastically modeling of the total project schedules. There is uncertainty surrounding any estimate of how long a task will take. If it is a short, simple task we have done before, the uncertainty range may be so small that it can safely be ignored. With large, complex tasks, the uncertainty becomes very significant, especially if we're depending on factors beyond our control.

Anyone who is serious about realistically forecasting project schedules, anticipating potential trouble spots, and taking action to mitigate against likely problems – in other words, truly managing major projects, rather than just monitoring them – should be using Monte-Carlo simulation software to plan and analyze projects stochastically. It is the best way to avoid late and over budget problems. Simulation has many advantages for risk assessment. Among them are:

- Simulation forces us to state our assumptions clearly;
- Simulation helps us visualize the implications of our assumptions;
- Simulation reveals the potential variation in the variables;
- Simulation quantifies risk (the probability of a given event).

One of the key measures of the resilience of any project is its ability to reach completion on time and on budget, regardless of the turbulent and uncertain environment it may operate within. Cost estimation and tracking are therefore paramount when developing a system.

The magnitude of each costs components depends on the size of the organization, the nature of the project as well as the organization management, among many considerations, and the owner is interested in achieving the lowest possible overall project cost.

Budget estimate must be adopted early enough for planning long term financing of the facility. Consequently, the detailed estimate is often used as the budget estimate since it is sufficient definitive to reflect the project scope and is available long before the engineer's estimate. As the work progresses, the budgeted cost must be revised periodically to reflect the estimated cost to completion. A revised estimated cost is necessary either because of change orders initiated by the owner or due to unexpected cost overruns or savings (Dumitrascu et al., 2010).

When we plan a project, we are attempting to predict what will happen in the future what we will produce, by when, for how much money. Prediction is always fraught with uncertainty. Our estimates are usually wrong because we cannot accurately predict the future. This is why we need risk assessment - it helps us to manage the uncertainty of the future (Naughton, 2012).

The risks of implementing and maintaining a QMS are well known. Although they cannot necessarily be eliminated they can be managed, and their impact reduced.

Based on information, obtained risks score and analyzed the case study regarding the risk management applied to a quality management system implementation, we can draw the following conclusions:

- Identified risks have a significant level of appearance and a relatively small impact;
- It has been identified risks, and the appearance causes on which will be applied corrective or contingent actions;
- Risk management plan ensure the prevention and treatment of risks arising for each stage of implementation;
- Risk management plan can be rebuilt according to other risks identified in the project.

Also, the case studies can be extended to costs assessment of project risks.

It is important to determine quantitatively the impact of event risk and determine the risks that cause harm (or benefit) for the project. So, it can build the sensitivity. They are used to visualize possible effects on the project (the best results and lower) the different unknown variables than their initial values. Variable sensitivity is modeled as uncertain value, while all other variables are held at baseline (stable). Tornado diagram is a variation of sensitivity analysis where the variable with the greatest impact is positioned on top of the chart, followed by other variables, in descending order of impact. It can be used for sensitivity analysis of project objectives (cost, time, quality and risk) (Barsan-Pipu, 2003).

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Chapter 4

What Quality Management Allied to Information Can Do for Occupational Safety and Health

Erika Alves dos Santos

Additional information is available at the end of the chapter

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1. Introduction

What quality management and scientific information can do for an organization will hardly depend on how it is applied in the workplace. Excellence seeking is an inherent practice to most organizations regardless its branch of activity. Loss prevention and market gains are usually presented as a justification for that. In consequence, quality management is closely linked to capital gain, and that is why enterprises apply high investments in this field. What is not explicit in this scenery is that all of this is also linked to scientific information and its correct dissemination. On the other hand, it is not a secret that market share, competitive advantage and profit are directly proportional to how informed one organization's leaders are about their business. In this context, it is pertinent to say that information is money, especially considering its high costs. It is also not a secret that information generates information. It means that the more widespread, more refined information gets, according to the spiral of knowledge that will be discussed ahead. So, the major input that can culminate in findings that may contribute for Science advancement is scientific information. However, two of several potential impediments to accessing and exploiting this vast field are resource scarceness and high costs of information access, and the scenery is the same in occupational safety and health (OSH) field. The barriers faced by OSH professionals during the information retrieval process, especially those derived from scientific experiments, generate the need for reflection on ways of promoting the intellectual capital turnover among professionals and this encourages the development of research instruments that enable the access to scientific information by the OSH community.

On this way, the Internet contributes significantly, whereas the virtual space favors fluidity, agility and possible reduction of communication noise between researchers, due to the possibility of real time communication, and that promotes the knowledge growing and also the improvement of security practices in the workplace. The significant increase in the volume of publications disseminated in the Internet without any criteria of quality and reliability of data is the result of the internet popularization, which contributed to the appearance of barriers in the selection of relevance information, and in certification of the legitimacy of presented data, particularly in OSH, in which information is scarce in relation to other areas of human knowledge.

An alternative to minimize the impacts caused by noise in information flowing is the creation of specialized virtual environments, called open archives (OA), which enable direction of the information to a target audience, promote break of bureaucratic practices in processes of documents publishing, provide interoperability between systems and communication in the scientific community besides promoting multidimensional ways of accessing studies made available by such routes.

Therein, the utilization of digital repositories of information under the philosophy of information spreading applied to the open archives initiative may be considered as an alternative to promote the intellectual capital turning as well as scientific communication among researchers. The initiative in question is presented as a strategy to support management of health and safety at work, together with quality management tools PDCA and 5S.

2. Knowledge management and scientific information in occupational safety and health

Among the barriers to information access it is important to highlight the linguistic obstacles that may difficult or even make inaccessible the consult to relevant studies, generally published in expressive international journals. These factors justify the promotion of technical and scientific exchange in order to form a professional experiences exchange network, that may assist OSH professionals in achieving satisfactory results on reversing the current degrading situation of working conditions, that are still found in several branches of professional acting.

Information is crucial to the effectiveness of OSH management system, however, in many situations, the information necessary for effective interventions are not available, restricted, for example, by temporal contingency. [...] The evaluation of the OSH management system is a systematic examination of its functionality and effectiveness in order to produce consistent information that may assist in decision making processes for the conception of new strategies to promote the improvement of OSH performance [1].

Engineering, Medicine, Law. All of these and the other fields of human knowledge exist because of information. It is also true that professional acting in any area offer occupational hazards to workers. Some more intense, some less so, but the fact is that occupational safety and health must be the basis of any professional activity, be at the office, or in heavy industry, so that the worker physical and mental integrity is always preserved.

Basically, two kind of information concern to OSH: prevention to accidents and occupational diseases and rehabilitation of occupationally sick or injured workers. The first one has proactive characteristics, while the second one seems to be reactive. An active posture allows the company to preview and prevent negative events, like an occupational accident, for example, and by means of this, save money or decrease spending, considering the expenses that the organization may no longer employ in professional rehabilitation. This means that the costs used in the prevention of occupational accidents and diseases should be treated as investments rather than as expenses.

Once the organization have identified the risks and opportunities in a pro-active way, the manager enables the tools to prevent or mitigate risks, maximize opportunities and reduce or eradicate harmful events to the employee and to the organization as a whole in consequence.

The burden of adopting a reactive posture is to expose the company to a totally vulnerable situation, in which it may not have enough time to any reaction in an emergency situation, staying at the mercy of events.

Scientific and technical activities are the fountain from where flow technical and scientific knowledge that will be transformed, after registered, into technical and scientific information. But, on reverse, these activities only exist, and become real against this information. Information is the Science sap. Without information, Science can not develop and live. Without information research would be useless and there would not be the knowledge [2].

Manage means to carry on business affairs, finance and human resources administration, what also implies to watch out for occupational health and safety. The purpose is common to all: to lead a particular activity or a group of them, to the achievement of one or more targets, which may vary according to the organization goals. Therefore, a range of compliances should be reached, and in case it does not occur, losses certainly will come, in most situations, with dimensions and impacts may vary from case to case. These factors highlight the importance of management and know-how to take advantage of all available resources, always keeping in mind the organization goals to perform tasks with the best coefficient of cost-effectiveness relationship. Management has the function to "build organization that work" [3], and to work, all sectors must maintain a synergy, so, one single action has the strength to move a whole, like a set of gears. By the way, this is the recipe of success which is unknown by so many companies. It is important that workers feel important to the organization and that their work has a real value to the company. As a returning, the worker would receive determination, and motivation, not only merely driven by obligation or interest (or duty) of economic nature. He will feel pleasure to work.

In the industry, machines and equipments receive a special treatment, with periodic reviews and replacement of components. The same way, the employee also requires some care from the organization, like the workplace adjustment and maintenance, for example. After all, the worker is the one who holds the most valuable asset of the organizations: the intellectual capital. The employee is the "keeper and guardian" of the organizational wealth, which is the knowledge. So, the same way a machine demands periodic reviews, small (or not so small) repairs, and even "vacations", the worker demands satisfactory work conditions as well, so it will be made the most of his potential efficiency. Psychological sphere certainly is very important in an occupational safety and health management plan. Considering that most part of the day of an employee is spent in his professional activities, the manager should also value the maintenance of a healthy work environment, both in physical and mental aspects. Many practices may be adopted in this sense: a good interpersonal relationship, relaxation techniques, profits sharing, regular meetings with the teamwork to identify their needs, and also the encouragement of reading and sports practicing are some valid measures for achieving a healthy work environment.

The adoption of such measures, linked do scientific communication may assist OSH professionals in developing management tools that support the employee in a large-scale way, providing better working conditions and health, both physically and mentally. In this case, information has the role to complement the knowledge of professionals who are responsible for zealous for workers' health and safety, besides giving wide publicity to the good practices adopted in this regard. Trainings, technical visits, lectures, simulations and other forms of professional improvement are also widely successfully applied. Added to appropriate information flowing, and also the valorization and respect for the worker, which may be made visible even in supplying adequate individual and collective protection equipments, the workplace may become a place that provides pleasant and well-being that may also contribute to occupational accidents and diseases prevention.

Occupational accidents, as well as any other accidents are unwanted events, unforeseen and which are generally accompanied by physical and / or material damages. Avoiding accidents and occupational diseases is the major concern of OSH professionals, and also a duty for any citizen. Appearing of occupational diseases, due to noise, high temperatures, radiation, exposure to chemical substances, and so on, is one of the greatest concern to hygienists [4]. An effective prevention program results in declining of occupational accidents and diseases rates and also declining of repair and consequence(s) of a possible accident [5].

This way, information sharing is crucial. A seemingly routine situation for one organization may be considered a risk task for one company which may already have had the unpleasant experience of an occupational accident as a result of that activity. Information like this should be as most widespread as possible (even though the company's name is preserved) to prevent other similar accidents from happening in other plants, or other organizations. However, the fear of intellectual overcoming, the organizational culture or even the fear of exposing thoughts to academic criticism sometimes keep the OSH professionals from starting an occupational hazards prevention discussion with other professionals.

Generating wealth and improvements from intangible assets is precisely the task of knowledge management, which is defined as a "new way of working, a new organizational culture, in which the environment and values allow to generate the necessary motivation for learning, sharing or transfer and application of knowledge [6].” In proportion to the knowledge becomes an essential and strategic asset, organizational success depends more and more on increasing the company’s ability to produce, gather, store and disseminating knowledge [7]. Thus, it falls to the company to promote knowledge sharing among the work team, and consequently the intellectual capital turning within the limits of their own plant. This point by itself is already a plausible justification for building an institutional repository of scientific information. Managing knowledge in organizations is to provide conditions for this knowledge to be constantly produced, codified and shared across the enterprise. Facilitate the interactive knowledge flowing in the organization, adding value to information and distributing them correspond to the role of knowledge management, transforming knowledge into competitive advantage [8].

However, for knowledge to be effectively converted into competitive advantage, it must be subject to application and transmission in the company. This conversion takes place through the transformation of tacit knowledge into explicit knowledge and tacit knowledge again and so successively until the results are tangible enough to satisfy, or preferably exceed the organization needs and expectations.

Tacit knowledge is acquired individually by each person, through courses, readings, lectures, or even the professional experience. The access to this knowledge depends on some factors, including the potential ability of explanation of the person who holds it. Another factor is the “ways of doing things”: each person develops their own way of working, aiming to make it easier and more comfortable. However, such procedures and techniques generally are not found in books, journals, films, or any other type of informational support, because this kind of knowledge only can be acquired through professional practice and experience.

On the other hand, explicit knowledge is available everywhere, to whom it may concern. So, explicit knowledge is more perceptible than tacit knowledge in an organizational environment. That is the case of books, journals, newspapers, magazines and so on. Explicit knowledge is what one can transmit in a formal and systematic language. It is the knowledge that can be registered in books, guides, or be transmitted by electronic mail or hardcopy [9]. In fact, information in general corresponds to explicit knowledge. Implicit knowledge is a more recent knowledge that serves to describe a knowledge that, though it has not been documented, it is likely to be. It is the knowledge one keeps, and is able of transmitting be in a more or less assisted way. Indeed this is the knowledge that can be made explicit, but has not been yet. For example: the way between one’s home and his workplace is registered anywhere, but this person can draw a map or explain someone how to get there. This knowledge is implicit: it is not registered, but it can be, if there is one’s will to do so. On counterpart, tacit knowledge the one that everyone keep, and have no conscience of that. It is personal, acquired through practice, experience, mistakes and successes, it is difficult to be formulated and transmitted in a formal way. A cake recipe (explicit knowledge), for example, can generate totally different results, depending on the experience and sensibility of the person who makes it. That happens because of the act of making a cake also involves a tacit knowledge, which is personal.

The conversion of tacit knowledge into explicit and vice versa, as in a cycle, promotes besides the human capital circulation and socialization, also the opportunity of renewal, acquisition of new knowledge, and promotes the improvement of the whole set of information already gathered. This information exchange cycle provides an intellectual capital spin, which encourage the socialization of generated knowledge, as well as the investigation and the reflection towards new knowledge creation [10]. The authors propose a model of knowledge conversion, what became known as knowledge spiral.

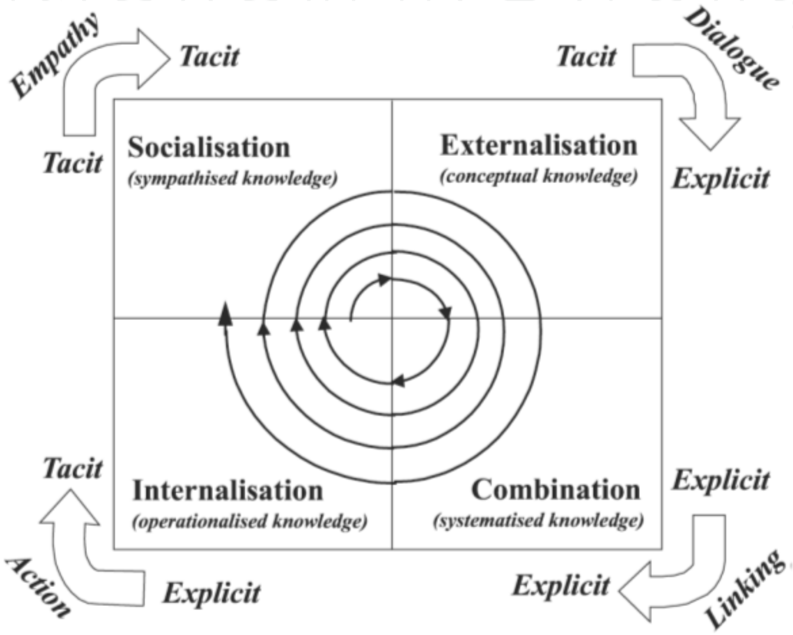

Figure 1. The knowledge spiral [10]

According to the model proposed by the authors, the process of acquiring knowledge passes through four stages:

- Socialization (tacit knowledge to tacit knowledge):

Observation and also the practice are ways of transmitting knowledge through socialization. In this process, there is much experience exchange, what is the big shot to knowledge acquisition. Trainings, brainstorming, and even one's own professional experience can be mentioned as examples of knowledge socialization.

- Externalization (tacit knowledge to explicit knowledge):

Externalization is the highest point of knowledge transmission. It is when occurs the encoding of tacit knowledge into explicit knowledge, so that other professionals can use such information, and convert them back into tacit knowledge. One of the tacit knowledge characteristics is precisely the verbalization high difficult degree. Scientific papers publicizing is a way to facilitate the transmission of this kind of knowledge.

Combination (explicit knowledge to explicit knowledge):

New ideas, new question and projects are designed in this stage. Explicit knowledge is confronted with another explicit knowledge. The result of that is the development of new information. Combination is very present in meetings, discussions, be in person, or by Internet, phone call, or even during a report, or even any other document reading.

- Internalization (explicit knowledge to tacit knowledge):

The conversion of explicit knowledge again into tacit knowledge occurs during internalization process. This is when acquired information is absorbed and right after, converted into knowledge.

Each time the cycle is completed, it should be restarted. Each restart is a higher degree of information complexity, specificity and consistency. Scope is also amplified as well, and may start with a single person and after expand across boundary of people, departments, sectors, units and companies. And information gets more and more improved and specific, until its holder becomes an expert in such question. To enable creation of organizational knowledge, tacit knowledge accumulated needs to be socialized with other members of the organization, and that gets another spiral of knowledge started again, as in a cycle with no end [8].

knowledge creation is divided in five main phases:

- The sharing of tacit knowledge;
- The creation of concepts;
- The justification of the concepts;
- The construction of an archetype and;
- The spread of interactive knowledge [10].

At the phase of tacit knowledge sharing, occurs the socialization, when information is shared through out the company. The creation of concepts corresponds to the phase in which there is conversion of tacit knowledge into explicit knowledge, as a new concept (externalization). In the third phase, justification of the concepts, the company evaluates and decides whether the new concept proceeds or not, and if there is continuity, archetypes are constructed and may generate new prototypes of products services and so on. The last phase, which corresponds to the interactive dissemination of knowledge, is responsible for systematic sharing of applicable information, in extra organizational sphere. This phase is extremely important for OSH management once this field of study focus is to promote welfare and protect worker's physical and mental integrity, while performing their work tasks. The capital gain and the competitive advantage originated from this process, although are both desired and very well seen, are consequences of the knowledge spiral cycle completion. The interaction of one company not only with the other ones, but also with the academic community, may bring great benefits in the sense of human capital acquiring, whereas active professionals in the labor market not always have the opportunity to research and publish new knowledge. So, the scientific community which traditionally carries out this task has much to contribute to the dissemination of research results, and by consequence, to the OSH management inside the companies, reaching, this way, until the shop floor, which can be considered the apple of OSH's eyes.

Any shop floor workers' tacit and explicit knowledge that the company makes use is very healthy to the organization as a whole. Even though experts develop great theories, the more accurate knowledge is held by the employee, which is the one who knows each single part of the processes in depth. As time passes by, working activity becomes an automatic process for a person, due to one's high intimacy level with the activity in question, and this relationship creates bonds that only the familiarity and the professional practice can establish. The "best and more efficient way of doing things" only can be indicated by someone who realizes it frequently.

Facing this, the interaction between the company and the employee is indispensable for the organizational learning to put foward tangible and satisfactory results, though it is also required the employee engagement, in order to be open to new experiences, new information and so on.

Relations with other organizations in the ambit of OSH can increase the spin of the spiral of knowledge, what can bring benefits for all involved in this process, because in contradiction to mathematical laws, knowledge gets multiplied when shared, and may become applicable to other areas like management risk, for example. Once there is a failure that may lead to an occupational accident, it is not enough only to fix it, but it is also necessary to warn the whole working team about the occurrence, for it not to be recurrence, avoiding any occupational accident, regardless its proportions. From the moment that there is the transmission of this kind of information, it becomes part of the knowledge of each single person of the working team, and that makes the likelihood of repeating the same incidence decrease. Through knowledge, companies become more effective and efficient in the use of their scarce resources. On the other hand, without knowledge they become less efficient and effective using resources, and fail, at last [7].

One of the factors that may contribute to accident preventions in an industrial plant is adopting a good quality management system. In contrast, quality is not put in practice without access to information. The efficiency is nothing more than the top of a set of information, arising very often from unwanted incidents, which are responsible for the generation of lessons learned, applied to a specific process, providing satisfactory results in order to improve products and processes. Considering these points it is interesting to stimulate investments in quality management and knowledge management, which is responsible for bringing up the tacit knowledge and experience of the workers, who usually hide valuable data for management in general. This fusion, in fact can bring great benefits to the organization in its various aspects.

3. The benefits of the fusion between quality management tools and knowledge management

A quality management tool is a methodology to improve processes using as less financial resources as possible, optimizing the working processes, increasing production, and also profit, by rational use of space, time and material and human resources.

Quality management tools are widely applied in organizational processes, and generally provide positive results. After all, quality is a crucial factor for optimization of processes, resources using, and the entire operation of an organization. The knowledge management benefits may be enhanced through the use of the resources suggested by instruments of quality management.

3.1. Organizational knowledge management and PDCA cycle

Organizational learning is a prerequisite for an organization existence. Or it is an organization that learns, or it will be condemned to failure soon. Considering the specificity of OSH field, the professional responsibility of monitoring the evolution in the industry becomes even greater and must be observed by each one involved in this knowledge area. However, for a company to learn it is necessary its employees learn first. In this sense, it is interesting to create policies to incentive the human capital acquisition aiming the organizational growth and improvement of processes in a larger sphere. The policy to stimulate education and multiply knowledge is important for the organization and in most cases, spending on research and development are usually recovered at short term, through improvements achieved by this process. This justifies high investments that developed countries apply in research development. So, a permanent cycle of knowledge acquirement provides to the organization the potential to achieve better results, exceeding expectations and achieving goals. The tasks improvement and staff expertise are merely consequences in this scenery.

One of the tools applied in this sense is the PDCA cycle, defined as method of managing for processes or systems. That's the way of achieving the goals assigned to the products or enterprise systems [11]. The word goal is the result of a junction between meta + *hodos*, that means a path to the goal. Thus, it is possible to affirm that the PDCA cycle is a way to achieve a goal [11, 12].

As the organization itself, all knowledge in any field of knowledge is like a living organism, constantly in change. Advances in Science and technology has created an scenery in which there is a need to create new ways of doing work, new strategies, new work tools and/or adapt existing ones to the new reality imposed by XXI Century. Each one of these items should function orderly among themselves, like a gear. So, all the processes of the larger organism, the organization as a whole, are able to flow correctly. Therefore, it is necessary to domain of some essential data for the proper functioning of this system. These data are often not found in books, or in the scientific literature, but in each employee's own experience, the tacit knowledge. In this sense, knowledge management assumes the role of contributing for each employee's intellectual qualifications to be always aligned to the mission and vision of the company which must include the promotion of safe work, and therefore, the occupational accident prevention.

Dissociating theory from practice is impossible, whatever is the activity about to be developed. Theory, due to hard studies, is the main responsible for the facilities and conveniences that can be observed specially on factory floor, as the machine protection and tasks automation, for example. Therefore, as business management, management in OSH knowledge should also be part of a continuous improvement process, like PDCA.

Conceived by Walter A. Shewhart in the 1930s at Bell Laboratories in the United States [12] and applied two decades later by the quality expert W. Edwards Deming (that's why PDCA cycle is also known as Deming Cycle) in statistics and sampling methods using, the PDCA method is recognized as a process of improvement and controlling that should be familiar to the employees of an organization to be effective [13, 14] CENTRO DE TECNOLOGIA DE EDIFICAÇÕES, 1994). Basically the PDCA cycle can be defined as

A method that aims to control and achieve effective and reliable results in the activities of an organization. It is an efficient way to provide processes improvement. It standardizes quality control information, avoids logical errors in its analysis and makes information easier to understand. It also may be used to facilitate the transition to a management style directed to continuous improvement [15].

The procedure proposed by PDCA implies constant evaluation of the entire system, enabling the early detection of possible failures or improvement points. This ideology makes necessary to conduct detailed audits at all stages of work. Each time the proposed cycle (plan, do, check and act) is completed, occurs the continuous improvement and then, improvement of knowledge of those involved with the activity in question, by consequence. In fact, the PDCA cycle is a total quality management method, which may (and should) also include the prevention of occupational accidents and diseases.

Whereas the world is constantly evolving, even activities performed satisfactorily are subject to improvements that must be pursued as incessant searching process for an unreachable perfection. That is called continuous improvement. Whenever it does not occur, the consequences are certain: occupational accidents are potentialized along with their indices of severity, losses and damages.

Occupational accidents do not happen by chance. They are just a materialization of a sequence of failures, whether human or not (although machine or mechanical failures also can occur due to human errors) which in most cases could have been avoided.

It is common for us to accept as true when the newspaper disclose, even before the experts report conclusion, that the origin of a fire was a short circuit in electrical installations. It is such an often cause, which examples are innumerable, that not even is necessary to wait a long time for the confirmation that was foreseen by journalists from interviewing experts and testimonials of the users of the hit building. […] What is not always demonstrated for the population is that the referred short circuit was not a surprise occasioned by an uncontrollable phenomenon, but the last breath of an installation that was agonizing. Fires, originated by electrical causes start, general rule, in overloaded circuits, without proper protection and maintenance, and handled by curious laymen covered up by "economic professionals" that seek by "the lowest price" the technical solutions for problems that should have been the cause for specialized diagnosis [16].

Failures, that not always culminate in accidents, but in near-misses, may be product of several factors, among which the lack (or insufficiency) of safety audits and knowledge domain by operators responsible for the activity that has any kind of inconsistency. The set of failures, combined with temporal factors may culminate in industrial accidents. Therefore, improvement must always be pursued by the organization, regardless its maturity level or any other factor.

The cycle proposed by PDCA requires constant evaluation of the whole system, in order to detect any possible failure, in anticipation of the occurrence of inconvenient and undesirable situations. Under this ideology, it is made necessary to conduct accurate audits at each single stage of the work. So, it will always be found new (and better) ways of doing the same things in a more efficient and safety way. Following the cycle Plan, Do, Check and Act (PDCA) is a way of promoting continuous improvement and thus, improves also the knowledge of everyone involved with the activity in question. Moreover, PDCA cycle is a method of total quality management, what also includes occupational safety and health management.

So, PDCA cycle is basically composed by four phases [12]:

P ⇒ Plan
D ⇒ Do
C ⇒ Check
A ⇒ Act

PDCA – P: Plan

The planning phase comprises the step in which all activities are outlined having the company's mission and vision as a point guide, besides other documents that may concern, like standards for example. Planning should point all the parameters of the activity, how it should be executed, financial, material and human needed resources, deadlines and all the information about the characteristics of the planned action, as in a project itself.

It is also in planning phase that are often identified needs hidden by the routine or even by convenience. Goals and methods of reaching them are all defined in this phase. Basically planning phase consists on the development and delineation of the project scope itself. That is why this is the proper moment to identify organizational weaknesses and strengths and develop strategies to convert weaknesses into strengths and strengths into points of excellence.

PDCA – D: Do

To do is to put into practice all that was planned in planning phase (P). It is like preparing a cake (do phase) following the instructions of a recipe (planning phase). This is the moment for training and educating employees, besides implementing all practices according to the project scope. Simultaneously, it can be a pre-audit, when positive and negative points of the plan should be identified and registered as a way of ensuring that all objectives previously established will be achieved in its fullness. This information also will be useful during the phase of checking the implemented actions.

PDCA – C: Check

Checking is the phase which most involves indicators and performance metrics, and comprises the comparison between planned and achieved results. Audits, processes analysis, evaluations, and satisfaction surveys are very common at this stage of the PDCA cycle. No inconsistency founded means the satisfactory following of the cycle. Otherwise, it is time to start the next phase: Act.

PDCA – A: Act

If the results are as expected, nothing should be done until the moment that any inconsistency is detected, when it is necessary to perform corrective measures to bring the project back to the scope initially established. However, besides implementing corrective actions, acting phase also may be in order to standardize processes that worked well, as a manner of registering information that can be used as stepping stone in similar situations. This phase corresponds to the PDCA cycle completion.

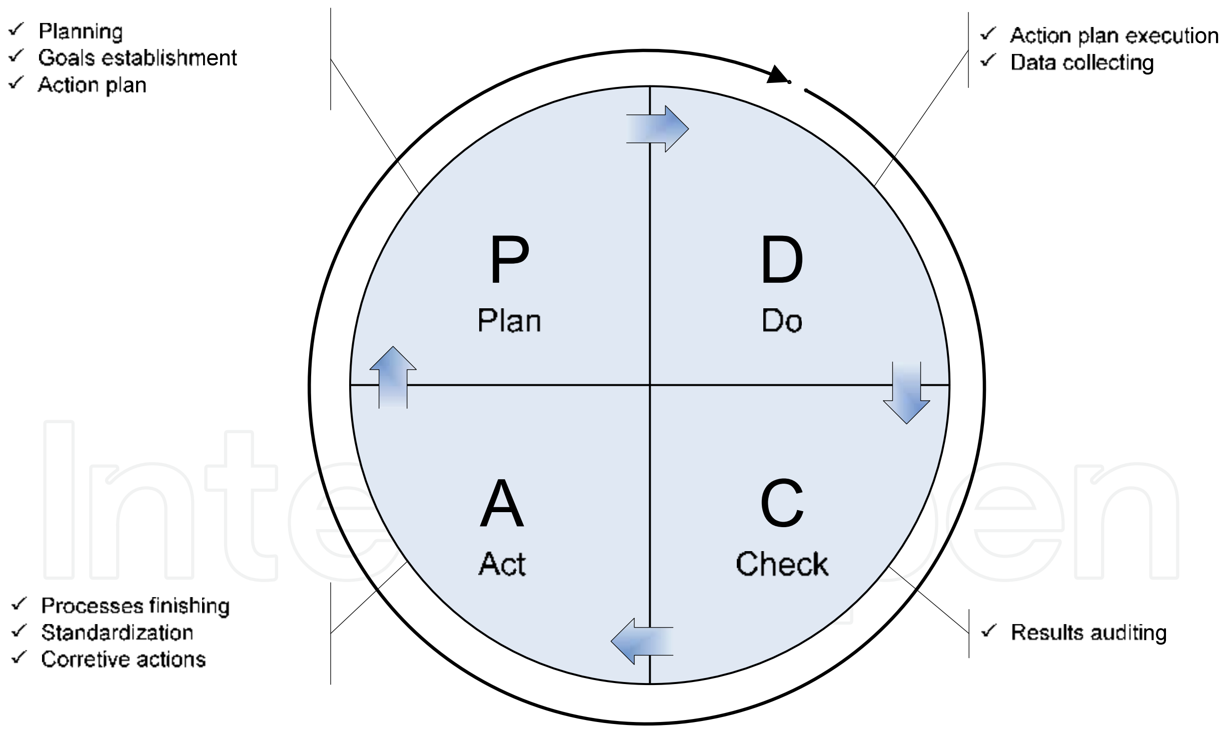

Figure 2. The PDCA cycle [12]

Once all those phases are concluded, PDCA has completed its cycle, which must rotate clockwise, following the sequence of the proposed activities. The most the cycle is completed, the greater the knowledge accumulated by the whole teamwork, in the same way that the rates of quality also will tend to be increasingly towards to excellence.

PDCA cycle is designed to be a dynamic model. The completion of a cycle will flow back in the beginning of the next cycle, and so on. Followed by the spirit of continuous quality improvement, the whole process can always be reviewed and a new process of change can be started [12].

The optimization of processes, reached through the PDCA cycle, promotes a reduction in costs and increasing productivity, what means creating new products, with less use of resources, which yields competitive, once production becomes higher than the competitors'. Likewise, the rate of complexity of information is growing each time the PDCA is fully completed. Each time the process is completed, the involved processes presents indices of improvements, which are represented by the numbers 1, 2, 3 and 4, according to figure 3. The closer to the top of the ramp are the improved processes, the better will be the indexes of maturity of the organization. Andrade (2003) points out that the lessons learned in a PDCA cycle application can be used in a second, third, fourth application (…) that can be more complex and daring, and so on.

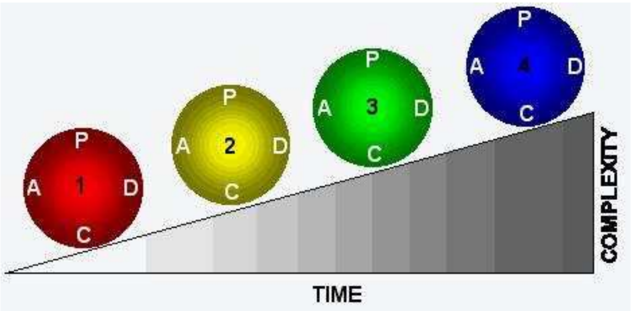

Figure 3. The improvement ramp [17]

The roll of information gathered can be a valuable instrument for the OSH management community, for the moment it is made available for public consultation as a data source of best practices, it may help managers to think globally and act locally. This way, the healthy and safe workplace will not just consolidate into one organization, but in all Brazilian industrial fabric.

There are several instruments for improving the quality of products and processes within an organization. Another instrument that can also be used together with PDCA to optimize the quality of work live is 5S.

3.2. Quality management according to the 5S process

Designed in Japan in 1950 by Kaoru Ishikawa [18], 5S is a method of quality management which aimed to delineate efficient and effective techniques to reach costs reduction, optimization of material, technological and human resources, and also combat waste [19]. It is an educational process, which is often applied as a basis for other management instruments.

The 5S program is a philosophy of work that aims to promote the discipline in the company through awareness and responsibility all to become the workplace a pleasing, safe and productive place.

The Program was named after five Japanese words that synthesize the five steps of the program. They are: Seiri, Seiton, Seisso, Seiketsu, Shitsuke [20].

The goals are to transform the environment of organization and the attitude of people, improving the quality of life of employees, and also reduce costs, waste and raise institutional productivity [18].

The 5S method may imply the improvement of other functions, not directly related in this process, such as production (acquisition of new equipments and adoption of new processes and systems), quality (standards application), human resources (adoption of new organizational policies), as well as hygiene, safety and environment (changes in management process, audits). For this reason, as well as any other innovation within a company, the implementation of 5S requires a detailed analysis on the budget funds to certify that financial aspects will not be an obstacle for the complete implementation of this instrument.

Another point to focus on is the possibility to be applicated simultaneously to other quality management tools, such as the Kaizen method of continuous improvement, safety, environment and quality management tools (NBR ISO 9001, NBR ISO 14001 and OHSAS 18001), Six Sigma, as well as PDCA Cycle itself. It demonstrates that 5S method is an extremely flexible tool that can be combined to other management instruments, what potentizes the results that can be reached by this method.

So, 5S acts in three organizational aspects, which are divided into 5 phases: physical aspects (Seiri, Seiton, Seiso), standardization aspects (Seiketsu) and behavioral aspects (Shitsuke). Each one of the five phases of the method is represented by a sense as follows [21]:

3.2.1. Sense of use and disposal (Seiri)

The sense of use and disposal awakens the workers consciousness to keep in the workplace only what is really necessary for the development of their functions. This provides to the worker a clearer, more accessible and easier to clean workplace, and increase visibility to the material actually used. Furthermore, this practice promotes the evacuation of areas previously occupied by unnecessary materials. Thus there may be an increase in productivity, reduction on bureaucracy processes, and prevention of unnecessary purchases.

The methods applied for materials disposal can be diverse: once separated all the unnecessary material, this can be transferred to other sectors, or returned to the warehouse, sold or donated for recycling entities, or even be disposed as trash, that also should be classified as common or toxic.

3.2.2. Sense of ordering and arrangement (seiton)

For each material, its proper place. The ordering sense recommends that once separated all the useless material, the remaining should be sorted in the workplace, preferably in the closest place to where its use is more frequent, location to which it should be returned as soon as it is not being used anymore. This provides benefits, for example the rationalization of the space designated to material storage, the encouragement of creativity, quickness, and facility in finding documents and objects. This reduces physical efforts and emotional distress in searching for not founded objects, besides preventing occupational accidents that possibly may be caused by a disordered workplace.

3.2.3. Cleaning sense (seisso)

Machine, equipment and any work tool including the workplace itself, must be kept clean and organized. The duty of maintaining hygiene in the workplace is not the sole responsibility of the cleaning crew, but also an obligation of each one of the employees. Cleaning makes the environment becomes more pleasant, and transmits the image of excellence in organization's products. And again, a cleaning workplace is less susceptible to the occurrences of occupational accidents, for example, a fall caused by a slipping way.

3.2.4. Sense of health and hygiene (seiketsu)

Personal hygiene is also essential as well as mental health and life quality in general. The good maintenance of employee's health is like an organizational intangible asset, as a prerequisite for the execution of any task in the company. However, this sense requires an holistic view that permits the manager to extend the meaning of health and hygiene also for the issue of OSS. The ergonomic adequacy of the workplace, the adoption of relaxation techniques, and even the aesthetic and disposal of the workplace are factors that must be considered in this way. As results, it can be achieved higher levels of team motivation, facilities in human relationships, dissemination of the positive image of the sector and also its employees, favorable working conditions to health, and also the occupational accidents and diseases prevention.

3.2.5. Sense of self-discipline (shitsuke)

The last and most individual sense is the sense of self-discipline. This corresponds to the regulator sense, which creates in a company's workers the awareness for the accomplishment of the four previous senses. This provides a natural implementation of all recommendations, the discipline, the moral and ethics, the cultivation of good habits, the promotion of participative management and also the ensuring of the quality of life at work.

The 5S program implementation may provide more efficiency and safety at workplace. The disorganization and lack of asepsis may be considered factors that may culminate in occupational accidents and diseases. The waste generates financial losses. The sense of using and ordering allow a better use of space, and finally, self-discipline, as the name suggests, promotes the discipline among the employees toward a policy of awareness in the use of the company resources. And what is more interesting in this process is that its cost of implementation is considered relatively low.

In fact, 5S may be integrant part of PDCA cycle. Both focus on quality management: 5S, aims to improve the quality of the processes and workplaces, while PDCA focus on strategical and managerial issues, although there is no restrictions for PDCA to cover some areas of 5S.

Both PDCA and 5S are quality management tools which may provide great benefits to an organization. It is also pertinent to point that, the implementation and management of both tools can be much more complex than it seems in this discussion. However, it is also important to consider that discussing these tools in a deeper point of view is not the primary objective of this discussion. These quality management tools were chosen and mentioned because they were considered useful in the sense of promoting the generation of information that may be applied in other workplaces or even other enterprises, through the association with a system of scientific information sharing among all of them. The management of safety and health at work can also be considered a quality management process, once it cares about quality of life at work, quality of safety processes, quality in the workplace, and so on. That does justify the association between quality management and OSH.

4. The fusion between cycle PDCA + 5S = Organizational benefits?

Increasing the quality and productivity while promoting quality of life, simultaneously with competitiveness: that is the great challenge of the manager / entrepreneur of the XXI Century. Whatever are the tools used to improve the quality of the work process within industries, there will be tangible benefits for OSH management.

An OSH quality management process may improve the systems applied in the worker safety and health:

As the organization adopts the audit protocol over time, it has the opportunity to experience the evolution of the performance of the OSH management system as well as the opportunities for improvement.

As it knows the opportunities of improvement, it becomes possible to develop an action plan focused on more expressive and efficient results, continuously improving the performance of the OSH management system [22].

Whatever are the instruments used to improve the quality of the work process within the industries, there will be tangible benefits to the OSH management. Equally, information systems also have their importance in this issue, since they are responsible for storage and make available case studies, which may be useful in identifying diverse points susceptible to improvements in organizational processes as a whole. Case studies, in particular, play a fundamental role in order to disseminate best practices applied by one organization, so other organizations also may be inspired in these cases to promote process improvement and quality of life at the workplace. Nevertheless, they have the potential to get the OSH professionals together, and promote the ongoing discussion about emerging issues in order to promote the prevention of occupational accidents and diseases.

The knowledge is available, the techniques, methods and tools exist and their use has proven results. At the same time, those who study the accident issue in a deeper way probably concluded that the best results only can be obtained from the holistic vision, both of the issue, and specially of the man. Innovating is a need! Dare to actually move toward a more efficient accident prevention which, at last, means to save lives, suffering, reduce costs, increase quality and productivity [23].

Information systems also have their importance in this regard, once several case studies are deposited and published there. These papers are valid to assist in identifying issues for the further improvements in organizational processes as a whole. Information management also is associated to knowledge to management quality [24].

In times when the quality, competitiveness and transparency are considered on determining an organization market share, there is too much to be explored about knowledge management inside the organizations, once explicit knowledge represents a very small portion of what the organization knowledge worth actually. It is also important to invest in capital for the intellectual training of employees in managing occupational safety and health at work. The worker is the most value asset of any organization because it is him who holds the most needed resource to maintain the business "health and force": the human knowledge.

Information, quality, organizational management, OSH, financial returns. Isolated, each one has its particularity, but applied together, these instruments converge to the establishment of organizational improvement programs, which benefit not only the client, but mainly the worker, who is responsible for the final product existence. The value of a worker for an organization is incalculable. Each time a life is lost, it is not only a worker who is not part of the staff of an organization anymore, but also a member of society, whom keeps a range of knowledge, which may still have not been disseminated. In this case, besides the worker, the organization loses a valuable intangible asset: the knowledge.

Effectiveness and efficiency of organizational improvement are linked to innovation to the method applied to available information sources and to the speed and flexibility which they apply, in addition to personal motivation, leadership practiced by the direction of the organization, and the relationship between the organization and stakeholders [25]. That justifies the importance of disseminating knowledge at most. The proposal is that the OSH and knowledge management are convergent in order to ensure that the quality management as a whole, not just the final product, may present strengths to provide better working conditions for workers, being subsidized by the provision of technical-scientific data from both tacit knowledge, and other professionals experience.

The availability and use of scientific information in an organization environment are fundamental to the process natural and safe flowing. And this safety may be built jointly by several professionals, through scientific dialogue, exchange of experiences and joint reflection. Accidents will always happen but if at least one live is saved by something that has been read somewhere, every effort will have been valid [26].

The principle proposed by Maguire seals the proposed link between scientific information and OSH management, and emphasizes the need to reflect on the creation of tools that enable scientific exchange among peers. The Open Archives Initiative (OAI) philosophy adds up this cause, in making available as much information as possible, specially the gray literature (thesis and dissertations, reports and other documents) which usually hold the results of observations, experiments and empirical reflections that may contribute to the OSH management.

5. The Internet as a source of data in occupational safety and health

Among the many emerging communication forms, the one which excels at terms of enabling the information transferring is the Internet, which is defined as a set of academic, scientific, commercial, and military interconnected networks, which communicate with each other through the use of a common protocol Transmission Control Protocol / Internet Protocol (TCP/IP) [27]. The authors highlight the facilities offered by the Internet to the scientific community like its globalization power, the immediacy of production, release, update and access to published information, the hypermedia capability (hypertext and multimedia), that makes it easy to search and access information as well as the volume of data gathered at relatively low cost, in addition to the possibility of interconnecting users, to eliminate barriers in the geographical, temporal, political, social spheres among other barriers to information transferring.

From the moment information has its value recognized, in the sense of being able to aggregate power to its holders, it became essential to generate resources to facilitate the information flowing among scientific community. The Internet has emerged in this scenery as a tool to add value for produced work, and increase visibility not only for presented results, but also to their respective authors and institutions. The creation of research groups besides the facilities offered by the virtual space, such as discussion groups and even electronic mail, narrowed the relations and facilitated access to the author of recently published works and this generates and enriches the scientific discussion, favoring the maturation of the collective intellectual thought [28].

The advent of Internet assured conditions for significant changes in ways of communicating among people, both in regard to communication media, and also the speed of data transferring.

The virtual ambient offers to the researcher agility in processes of production, evaluation, publication and validation of the essays. In printed media, the communication flows slowly, since the entire process of developing a new publication, which involves reviewing, formatting, graphics constructions and other activities related to the completion of the research are made prior to its publicizing. On the other hand, in digital environment, the processes of review and validation of works, through scientific proof, may be done jointly with the target audience of the work, accelerating the process of information transferring. Thus, the high levels of formality in contact with authors, give way to interactivity since a simply electronic mail replaces the content of an official letter, which could take several days to reach the final destination. The Internet enables immediate and direct contact with members of the community to close relations between scientific researchers.

It is true that the Internet being a network of networks with services of electronic mail and thematic discussions in group facilitates the informal communication between researchers in different areas of Science & Technology. And when one think that informal channels are essential to work at levels of great value added to the information, because they are useful in decision making and allow the creation of strategies from unpublished information, one can have an idea of the value of the communication network [28].

It is worth an interesting comparison between the virtual environment, and the typical scenario of scientific events such as symposiums, conferences, and discussions, exchanges of experiences, and other considerations that both enrich and add value to the collective intellectual thought. The scientific dialogue promoted in digital media, is like an extension of the shared moments of reflection, always present in scientific events, round tables, sessions of questions, debates etc... In this sense, the authors refer to the facilitation of informal communication, once at a conference or other event of this nature, there is the establishment of a direct dialogue between authors and the target audience of your statements. The virtual space in a way, also promotes this feature, since once that there are two computers connected to the Internet, the communication between them can be directly established at any time. A dialogue is formed since there is a transmitter who sends a message to a receiver, who decodes and process the sent message, and generates a response for the transmitter, who assumes the position of receiver at this moment, while the receiver, passes to be the transmitter. It is also true that this not always happen be due to the unavailability of the receiver, be due to human or technological failures in the moment of message sending, but this, not necessarily consists a barrier to scientific dialogue.

Even so, the Internet can be considered a way of direct communication between two or more people which may offer great benefits to the scientific community, when applied properly. By using this computer network, the scientific debates which are usually made in scientific events, are able to extend for an indefinite period, rather than being limited to the 15 or 30 minutes generally reserved for complaints in events. With this, the author-reader interaction enables the clarification of one or another aspect addressed in the work that deserves a greater detailing, creating opportunities for the improvement of qualitative indices of the work presented, since any failure or passages that deserve special attention, will certainly be raised by the community members. Thus, a particular work is no longer individual, but will incorporate the collective thought, expressing the opinion of a community on a given topic.

The consensual opinion of the scientific community, which is one of the most fundamental standards of Science, is that the works should be disseminated by their respective authors [27]. The act of publishing enables that a research result be recognized as scientific truth, through validation of theories presented [29].

Interestingly, the publication and dissemination of information are essential to the development of new studies, since previous publications may be considered as inputs for the development of new studies as a way of providing greater credibility, validate, demonstrate and emphasize the new data submitted. Thus it is formed a scientific dialogue among different authors, which is precisely what makes possible the verification of the premises presented, and encourages the generation of new studies, and instigate researchers to explore emerging topics in their respective areas of expertise.

In this context the Internet is presented as the support which receives such a dialogue, which can also be called scientific debate, giving continuity to the information cycle which is responsible for the generation and improvement of human knowledge. Just as in other areas of knowledge, in occupational safety and health the Internet is a powerful tool while helper and source of research in professional forming, or continuing education in OSH, specially in remote, poor and less assisted geographical areas.

Additionally, the option of publishing in electronic format offers various facilities, both to the author of the study, and the information units, that later will incorporate such publication to their collections, with possibility of eliminating decisive processes of production and dissemination of knowledge that includes the best way of providing, acquiring and disclosing information, how much to spend, and so on. The stages of the publishing process is generally lengthy and costly - factor of impediment to the publication of works for many writers - is broken, since the cost of publication in digital format are lower in relation to the printed publication, not to mention validation activities, which in this case are made collectively by the entire scientific community, speeding up the improvement of publication process, and covering topics since from formatting and standardization until wording and content revision.

From the viewpoint of the information user, the greater and most social visible benefits and probably the most relevant ones provided by digital publishing are:

- The possibility of simultaneous access by multiple users to the same document;
- The facilities of handling, transporting and transmitting data;
- The possibility in converting the digital media in a printed document;
- The versatility of the media;
- The possibility of breaking down temporal, geographical and linguistic barriers.

The benefits of electronic communication are numerous and surrender itself a new research. The trend that has been the cause of controversy among scholars is that the volume of information produced in analog format, (paper) decrease significantly. Many publishing companies and other organizations are already producing their journals only in electronic format, which generally corresponds to the CD-ROM or online versions. Besides the benefits discussed, the fact brought the rationalization of physical spaces for storage, cheapening of resources for conservation of material, since the digital media tends to be more resistant to decay in relation to the paper. All this, not considering that traditionally, printed periodical publications only can be accessed inside the information units dependencies, with no possibility of home loan, which can cause potential complications or even impossibility of consulting the material by the researcher. Such restrictions do not occur with electronic publishing, since its contents can be duplicated for another media, and transported for consultation in another location, without making the original document unavailable for immediate consultation in its unity of origin.

From the moment in which the publications are available exclusively in electronic format, there is an increased risk of excluding many people from the scientific discussion, considering all these people that has no access or are not familiar with the digital environment, and thus the whole purpose of facilitating access knowledge, promote scientific integration, and provide visibility to published researches is inversely reached.

A possible solution to this situation may be to provide equipment connected to the Internet in educational institutions, both public and private, with monitors for guidance on access to information. However, the fact is that even though these facilities are available, they are not sufficient to eradicate the digital exclusion. The reasons are diverse, ranging from disinterest of the public to the lack of available equipment. Considering the global trend, driven by globalization, which initiated the computerization era, it becomes necessary to establish a national policy to encourage the generation and use of electronic information, so that the country can keep up with advances worldwide, regarding to the development of information retrieval systems. On the other hand, although the scientific information does not reach 100% of the public involved, managers often have easy access to these kind of data. It is up to them so, to consult such information and transmit them to their whole staff, so that scientific language is properly converted to the worker understanding, which constitutes the focus on OSH management.

However, the fact that the information is available does not mean that it will be accessed and converted into knowledge for further practical application, when applicable, as a way of promoting the advancement of OSH, and consequently the welfare of the worker. Thus, the OSH class institutions, together with the units and information professionals, play a crucial role in order to highlight and promote the use of this vast material, which stores the inputs to the construction of knowledge, and also provides support to the professionals of the area for such actions to achieve remarkable and satisfactory results. This responsibility increases from the moment that is considered the fact that the OSH institutions are the main producers of information on this subject. So, a new necessity arises, besides an encouragement for computerization, creation and scientific knowledge communication. The investigative spirit must be something inherent to the researcher, so that he must feels the need for seeking information involuntarily, and do not expect something to emerge that bring it to him. Hence the need to develop the instinct of independence in these professionals to have greater autonomy to act in terms of information searching and scientific expression.

In this sense, knowledge management plays a key role considering the need to promote the scientific informational capital turnover allowing the maturation processes of knowledge management within organizations. The benefits offered by the Internet allow the process of information transfer to increased speed and efficiency to ensure the safety of workers more effectively, reducing the rates of occupational accidents.

According to tables 1 and 2, official statistical data from the Brazilian Ministry of Social Welfare (Ministério da Previdência Social – MPAS) indicates that from 2008 to 2010, Brazil has registered over 700.000 occupational accidents a year, resulting in more than 8.000 deaths. Important to remember that these numbers do not correspond to reality, once that underreporting is still a problem faced in the workplace. Statistics themselves, better than any other data, justify with great skill the necessity of reflecting on the working conditions not only in Brazil, but all around the world, and, above all, the need for developing effective tools in reducing these rates.

Number of occupational accidents registered by Brazilian Ministry of Social Welfare, from 2008 to 2010														
Total number (with and without CAT registered)			With CAT** registered											
			Total with CAT registered			Cause of the accident								
						Typical accident***			Commuting Accidents****			Occupational diseases		
2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010	2008	2009	2010
755.980	733.365	701.496	551.023	534.248	525.206	441.925	424.498	414.824	88.742	90.180	94.789	20.356	19.570	15.593

Table 1. Number of occupational accidents registered by Brazilian Ministry of Social Welfare, from 2008 to 2010 [30]

Number of occupational accidents in Brazil, by consequence, from 2008 to 2010							
Years	Total	Consequence					
		Medical assistance	Temporary disability			Permanent disability	Deaths
			Total	Less than 15 days	More than 15 days		
2008	774.473	105.249	653.311	317.702	335.609	13.096	2.817
2009	752.121	103.029	631.927	306.900	325.027	14.605	2.560
2010	720.128	97.069	606.250	299.928	306.322	14.097	2.712

Table 2. Number of occupational accidents in Brazil, by consequence, from 2008 to 2010 [30]

** CAT (Comunicação de Acidente do Trabalho) is a form that the company must fill in to communicate to the INSS (Instituto Nacional de Seguridade Social / National Institute of Social Security - Brazil) a work accident, which occurred with an employee, with or without removal, until the first working day following the occurrence, or immediately, in case of death, under penalty of fine.

*** A typical accident is the one with happens during the execution of a professional activity.

**** A Commuting accident is an accident occurring on the habitual route, in either direction, between the place of work or work-related training and:
(i) the worker's principal or secondary residence;
(ii) the place where the worker usually takes his or her meals; or
(iii) the place where he or she usually receives his or her remuneration;
which results in death or personal injury (http://stats.oecd.org/glossary/search.asp)

Achieving development is a virtually impossible task if at least the minimum conditions to preserve the physical and mental integrity of the worker are not observed. Therefore, work, health and safety are three components that must walk and advance together. From this perspective, the Internet can be applied as an instrument that enables and facilitate the scientific information flow and also the OSH intellectual capital turning, especially in underdeveloped regions, where the levels of exploitation and misinformation are higher.

So, the Internet can be considered an efficient tool for communication and dissemination of organizational knowledge, which assists in the process of homogenization of knowledge among employees of an organization. Information is essential to any organization, including all its workers, be from top management, be from shop floor, and emphasize the need for rapid access to data to reach the open market, competitiveness and also quality [31]. For this it is necessary to reveal the way in which information technology interact with organizations, since according to the literature, it is by this process that occurs cultural changes what includes the interlocutors behavior, which yet can involves business results, motivation and well-being of employees.

Information technology is a powerful tool to maximize the number of people reached, especially in shop floor, where can be found workers that have all the conditions to opine on a subject, resulting in new ideas, aiming to optimize ways of working and even getting better relationships among the staff. It is up to OSH professionals, to recognize the resources applied by information technology as a tool for OSH management in Brazil, so there will be a really valid and visible contribution the worker point of view.

1. It should be generated by means of empirical thinking;
2. It must be liable of understanding and proof;
3. It must be formerly communicated to scientific community.

The most common form of communicating scientific information is by written communication (publication of books, articles, essays and so on) or by oral communication (informal conversation or oral presentations in events like congresses, seminars, symposiums and so on). Which one is better in OSH field is a hard question, because it depends on several factors, including the nature and complexity of information to be transmitted. However, written media is still the easier way to access scientific information, once participation in scientific events may become unviable due to geographic limitations or even budgetary restraints. So, an alternative to overcome these barriers to information access is to create information systems designed to store, preserve, disseminate, and promote access to intellectual output of the scientific communities around the world, preferably in an open access ambient, to overcome another barrier to scientific information: its costs.

Considering the opportunity of promoting collective thinking on OSH and the conveniences offered by digital age, some reflections emerge in order to build and encourage the use of instruments that allow scientific communication flowing. Therein, the Open Archives Initiative (OAI), coupled with the proposed mechanisms for quality management, emerges as an instrument with high potential for promoting a healthy and safe work environment for workers, overcoming geographic, temporal, and possibly linguistics barriers, facilitating access and dissemination of information.

So, scientific information reliability and validation is based on three points:

6. Digital information access resources under the open archives philosophy

Success and professional recognition are the targets of any professional, but only can be achieved against great deeds. For that, the main additive is a good quality information made timely accessible. Precisely for this reason, information has been increasingly valued and pursued by all professionals.

The society has watched to an informational explosion along the last few decades, both in qualitative and quantitative aspects. Many facts should have collaborated to it, for example, the need of publishing, to get or to maintain a job [2]. This is a common practice in the academic world. However, regardless of the reason, information is there, everywhere, to whom it may concern. Once available, information has to be communicated, for it to have its worth, and to achieve its objectives. Internet has contributed significantly for that, as an effort to facilitate the access for information, and communication processes among scientists and researchers, that is, the scientific society, defined as a social group formed by of individuals whose profession is scientific and technological research [2].

But how do these scientific communities work? By the same way that did the primitive societies: by donation system. Scientists transfer their knowledge spontaneously and gratuitously to the scientific community, without expectation of receiving any economic compensation in return [2].

However, the existence of use and production of information become useless, if whomever may need it do not know about its existence or can not retrieve it, whatever the reason. Just for this not to happen, any effort towards making information available to as many people as possible is valid. Thus, facing the scenery described, arises the incentive to free access to scientific information that

as already extensively reported in the literature, is both the result: (a) of a reaction of researchers to the business model of scientific journals commercial publishers (and their increasingly high prices for […] signing and (b) increasing awareness of the impact caused by availability of scientific papers free from access barriers. The motto of the worldwide movement in favor of the Open Access search results, therefore, is the wide and unrestricted dissemination of the researches supported by public resources [32].

Considering that information can play the noble task of generating and disseminating knowledge, which through an empirical combination (scientific communication), may culminate in the development of increasingly effective tools for building and maintenance of healthy and safety work environments, any expenses for this purpose, either with job training (input) or with the access and dissemination of information (output) should be considered as an investment.

Facing this, the Open Archives Initiative may be applied as a tool for adding value to quality management in OSH, while providing information, including successful reports, which may be adapted and possibly applied in the workplace, aiming to promote better working conditions for workers.

Open archives (OA), which can also be considered an information quality management tool, are seen as an innovative concept designed to provide the text as quickly as possible, promoting and popularizing free access to electronic publications, so that there is a weakening of the monopoly detained by the publishers upon any scientific publication until then [33]. The OA established a set of standards that enable interoperability between different digital repositories, which [34], are defined as a form of storage for digital objects that have the ability to maintain and manage material for long periods of time and provide proper access. Becoming the main forum for dissemination of scientific results and discussions [35].

Digital repositories of information are information systems which are intended to storage, preserve, disseminate and promote access to the intellectual output of the various scientific communities around the world. The main features are the extensiveness of public access, the variety of documents regarding to form and content, including aspects of interdisciplinary and preservation of digital data stored in there, and also the storage of this kind of informational support, that dispense the formation of the traditional printed collections, that demands above all, physical spaces for the accommodation of the archived material. However, the differentiating feature of open archives is the ability to provide simultaneously, freely accessible documents, using the philosophy of self-archiving, and also more restricted documents, made available only to a select audience, such as researchers engaged in a specific educational institution, for example. This way, digital repositories may present both interfaces: one widely and opened accessible, and another one, more restrict, gathering both the philosophy of free access, and the digital repositories philosophy itself. The policy used in the process of adding new documents collection ever assembled determines the repository as open archive, or digital repository. In the first case, the name refers that the information access is completely open, allowing the authors to remove or alter documents already posted whenever they found it convenient. In digital repositories, instead, access is restricted to a specific community, such as university professors or researchers from an institution.

Since digital repositories are constructed within the philosophy of open access, the final user of this kind of information source is able to search, copy, print, and also send a document to another researcher besides the possibility of using the full text documents in other discussions, since the source and authorship is indicated. The data reliability is ensured through quality policies that establish minimum standards of quality of the archived information. A way of applying this sense is to have a specific judging commission, which should be responsible for examining the papers submitted for publication before making them available in the network.

The popularization of the Internet contributed to the depreciation of the degree of reliability of the data available in there, since anyone that dominates some basic features of information technology are able to add and/or change data on the network, inserting new documents and information that are not always reliable or truthful. The thematic digital repository under the philosophy of open archives, however, can mitigate such effects, recovering the initial principle of scientific communication in digital format, which is to facilitate the scientific information exchange between professionals.

Usually maintained by renowned institutions, thematic repositories adopting the philosophy of open archives gather in one place plenty of documents on a specific issue. That saves the researcher free time, and eliminates the need of displacement until an information unit or a library to have access to such data. Therefore, rather than the researcher looks for information, the opposite is what happens: the information comes to the table of the researcher, through a computer, bringing with it the backing of the institution responsible for its authorship.

The establishment of the open archives initiative in Brazil, may contribute to the breakdown of the barriers to access to OSH information, and also promote joint reflection between the members of the scientific community. The self-archiving, defined mechanism that allows the authors to submit or deposit their papers in a digital repository [36] besides being a way of democratizing forms of publication and access to scientific information, is also a way of promoting the continuing debate about a subject among scholars. The contribution to the construction and sharing of knowledge in this scenario becomes an automatic process, in order to contribute significantly to the evolution of science and improvement of various forms of labor relations in the OSH context.

7. OSH information management in São Paulo city, Brazil, under the professionals perception

During the year of 2008, Santos realized a study (presented as a master dissertation) in the south area of São Paulo City, in Brazil. The objective of this study was to detect the perception of the OSH professionals regarding to the availability of scientific information in occupational safety and health, and ways of accessing it, in their perception. It was also investigated the perception of the OSH professionals about how OSH scientific information and the maintenance of a healthy working environment could contribute to increase quality indicators, and consequently the organizational profits, that corresponds to the managers and stakeholders main interest.

It was randomly selected 23 organizations of the south area of São Paulo city, which OSH professionals were interviewed. 52% of the studied population consisted of safety technicists, while safety engineers consisted 21% of the total sample. The profile of the selected community was characterized predominantly male (82.6%), ranging in age from 36 to 50 years and over 10 years experience in the area.

The analysis of the answers to the 17 questions questionnaire that was applied to these professionals indicated that there is still a great job to be done to improve OSH information access and application in companies in São Paulo. It was found that the virtual environment for research is not yet fully exploited by the respondents, which is a fact that arises some concern to OSH managers, considering all the benefits of this knowledge transfer resource.

With regard to the worker welfare, the results clearly show that access to information is essential for safety processes improvement. Workers physical and mental health protection depends largely on access to the occupants of senior professionals have to the scientific information in general. According to respondents, cross-check between one and another company is very important in order to improve techniques and processes to assist in decision making or problem solving.

The study results also showed the need to promote the practice of OSH management as a means of protecting workers, and not as an inspection agent with punitive power to those who fail to comply with its recommendations. The worker must have a different view of safety at work, as well as professionals working in the area. Therein, integration and awareness of employees through information once again revealed itself effective. Information by itself is not the key to all problems solving , but it may be a major step in building and maintaining the ideal working environment. Data exchange among companies provides the sharing of experiences, improvement of processes and support in the prediction of harmful events, the accident itself.

The initial premises, which were confirmed at the end of the study, indicate that the philosophy of dissemination of scientific information used by open archives is considered by the interviewed professionals as a support tool for OSH management. Regarding the attitude of these professionals, the acceptance of this new form of dissemination of scientific information is plausible, although the reliability and familiarity of the public with digital instruments of research is relatively low, what creates the need of promoting the scientific culture, which stirs up both production and sharing of information, and above all, the scientific papers publication.

The discussion emphasized that scientific information can be viewed and used as a support tool to OSH management in general, which is considered a pillar to occupational safety and health management. An information resource would help professionals in the area, be in decision making processes, be in technical aspects. Allied to the mechanisms for quality management, benefits are enhanced with the possibility of achieving significant results to organizations.

8. Final considerations

It is important to establish the alignment of the alliance among scientific information, quality management and occupational safety and health. This combination, stands for the interests of OSH professionals, workers (including shop floor), and managers. OSH professionals, through the access of information are able to improve their professionals skills and apply methods of accident preventions never experienced before, or experienced in other organization, while quality management tools, like PDCA and 5S may help them to evaluate the adopted measures, making easier the identification and correction of any fail, and also to provide a clear, organized and healthy work environment, through the 5S recommendations. Workers, may enjoy a better (friendly) work environment, ergonomically correct, cleaned and organized job stations, not to mention the perception of the importance of him and his job to the organization, and also the improvement of occupational hazards management, once a suitable working environment reduces the chances of the occurrence of occupational accidents. For the organizational manager, all of this represents profits increasing. Once the OSH professional has conditions to offer a proper workplace in the organization, the worker is able to produce more, and more efficiently (profit). The worker, less susceptible to occupational accidents, requires less spending with medical assistance and rehabilitation costs (profit). Conscientious use and disposal of organizational raw material, also represents saving money (profit). PDCA also has its contribution in this sense through the provision of the constantly evaluation of the production process, what allows the organization to keep a continuous evaluation and improvement process, towards excellence, which may represent the conquest of market share (profit).

Increasing production and quality indicators, decreasing occupational accidents, using raw material properly (including human resources), and all of this supported by scientific information, meet the interests of any organization manager which is profit. In this scenery, the effective use and application of scientific information and communication may be considered as one of the major challenges, to be reached by occupational safety and health professionals. Since OSH is a branch of knowledge that deals with human life, comfort and safety become priority issues in order to provide the quality of work life, especially in activities that exposes the worker to occupational hazards, which risks both safety and even the workers lives.

However most needed material goods, we must not forget the following: **ALL OF THIS EXISTS FOR THE MAN.** And he can not have his health unprotected. The workplace control is obligatory. This is a matter of morality. If the work does not contribute to your happiness, it will be a huge and lamentable loss [37].

In work accidents field any kind of adaptation must be unacceptable. After all, a worker who is mutilated by an occupational accident, hardly will to adapt to society and the workplace in order to carry out their routine activities. The accident scene will never be erased from his memory. Neither compensation, (no matter the value) nor any other social benefit will aid the psychological trauma of an injured worker, or replace the activities of which he was deprived as a result of an accident. Therefore, it is inadmissible to use the term adaptation when it is related to safety and health at work, since the health and integrity of the employee is an acquired right that must be respected by the employer.

Knowledge attracts money, while the converse is not true. Whereas the non-conformities in the workplace may culminate in damages to the organization, investments in the development of the intellectual capital and management knowledge should be priorities to the organizations and be considered as support tools for managing health and safety at work.

Quality management should promote effective changes in the workplace, and these changes should reach and invigorate in all working environments, so that the workers lives, which represents the strength of a nation, be respected and preserved.

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Chapter 5

Reducing Mirror Slippage of Nightstand with Plackett-Burman DOE and ANN Techniques

Mithat Zeydan and Gülhan Toğa

Additional information is available at the end of the chapter

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1. Introduction

Understanding the behaviors of the systems is possible by conducting some experiments. But, experiments have to give all needed information in a reasonable manner; especially time and budget for the experiments are main constraints in a system observation. Identifying the key factors of experiments which have impact on the process and conducting all trials relevant with key factors are very difficult. It is difficult to make analytical and numerical modeling in complex processes and the real life problems which have many parameters that affect the systems. To prevent all these negativities, design of experiment (DOE) is an indispensable method which observes systems behavior. It is a systematic approach to find how inputs affect the system outputs and also provides a continuous improvement for processes and explores relationship between key input variables and output performance characteristics by existing and performing a designed set of experiments. Key input variables can be defined as factors (independent variables) and outputs can be defined as response (dependent variables)[1]. A well organized experimental design needs a design matrix (Orthogonal) prior to experiment. The design matrix contains all the settings of factors at different levels and also gives the order of experiments. The number of factors and interactions, levels of factors, budget and resources define the size of experiment[2]. Design of experiment was firstly used for agricultural applications in 1920s and became a popular tool observing systems and processes. Many books and journals have been published about the applications of Chemistry[3], Biology[4], Statistics[5] and Engineering[2] for years. Optimizing the levels of factors, finding interaction relationship between factors and response, making a fast decision, improving the system performance are some advantages of DOE[6].

Some design of experiment methods used in the literature are Full Factorial Design, Fractional Factorial Design, Plackett-Burman Design, Central Composite Design, Box-

Behnken Design, Robust Parameter Design, Computer Aided Design and Taguchi. Taguchi method has a wide usage in the engineering applications but criticized in the literature about not concerning with the interactions between factors while focusing on evaluation of main effects totally[7]. It is one of the most important tools that can be used for improving steps of Six Sigma loop[8].

This application study which was done in furniture manufacturing firm in TURKEY to prevent the mirror slippage of nightstand is analyzed from the point of Six Sigma philosophy view. The structure of the rest of the paper is given as follows: In Section 2, it is described in detailed about the concept of six sigma. In Section 3, the application of the artificial neural network is presented. In Section 4, conclusion is given as evaluation of the results.

2. Application of Six Sigma

Manufacturing sector has to provide perfect products and produce fast, quality and economical products to their consumers because of severe competition in the market. As all businesses reach this purpose, their processes must be stabilized or kept under control with continuous improvement. Six Sigma that provides continuous improvement is a key to being successful in business. This management philosophy which uses some statistical and systematic approaches will prevent defects. Providing continuous improvement in a system is a result of applying the loop of Six Sigma in correct order and identifying relations between inputs and outputs. This loop is made up of the steps of Define, Measure, Analyze, Improve and Control. Some quality and statistical methods are being applied in all these steps[9]. The most used Six Sigma tools are Design of Experiments, Response Surface Method, Robust Design, Statistical Process Control, Quality Function Deployment, Failure Mode and Effect Analysis, Capability Analysis, Hypothesis Testing, Analysis of Variance, Regression Analysis[10]. Sigma (σ) is a letter which represents the variability and standard deviation in the processes. On the other hand, Six Sigma identifies how a deviation is shown from the perfect conditions[11]. The significant factor in six sigma process is to share responsibility in an organization. For this reason, everyone has different responsibilities depending on their education[10]. Organization structure can be addressed as Leadership, Champions and Sponsors, Black Belt, Green Belt, and Master Black Belt[12]. Applying Six Sigma tools in manufacturing processes provides reduction of defect rate, cycle time, manufacturing costs and improvement in quality and productivity[13].

A Six Sigma application study was done in a furniture manufacturing firm in TURKEY. Steps following for the application of Six Sigma by considering DMAIC loop is given below.

This six sigma application study was simulated with a mechanism which rotates the mirror nightstand (Figure 2) having constant speed. Thus, slippage resistant of mirror was measured. While running the system, if it stands out against slippage more than 72 hours (based on expert opinion), this situation is called as “no slippage”.

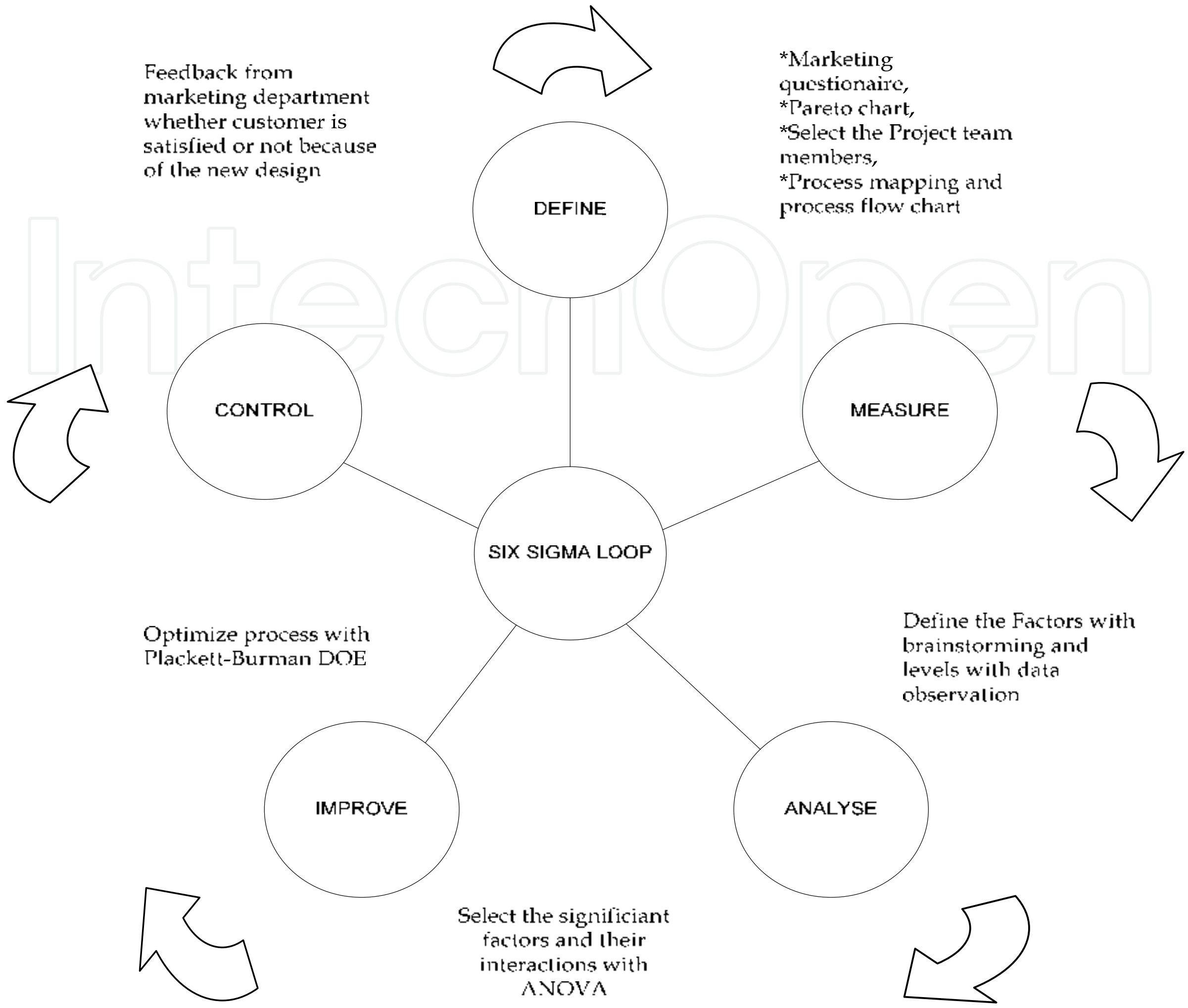

Figure 1. Six sigma loop

Figure 2. A Nightstand Sample

2.1. Define

In this stage, following steps should be applied;

- Required studies are done to define systems' problem,
- A team is constructed for solution,
- Follow-up method is selected
- Goal is defined by analyzing process carefully.

In the application, a marketing questionnaire was applied to customers of the firm to find the reason of the problem. This project's objective is reducing the customer complaints of the manufacturing firm about nightstand mirror slippage. As a result of questionnaire, pareto chart shown in Figure 3 was constructed by using data about product returns. It is seen that one of the significant complaints (%7) are dealing with slippage of glass on the nightstand and we selected this problem for obtaining a fast improvement. A quality engineer, a foreman from the plant and two persons from university were formed a team for this six sigma application.

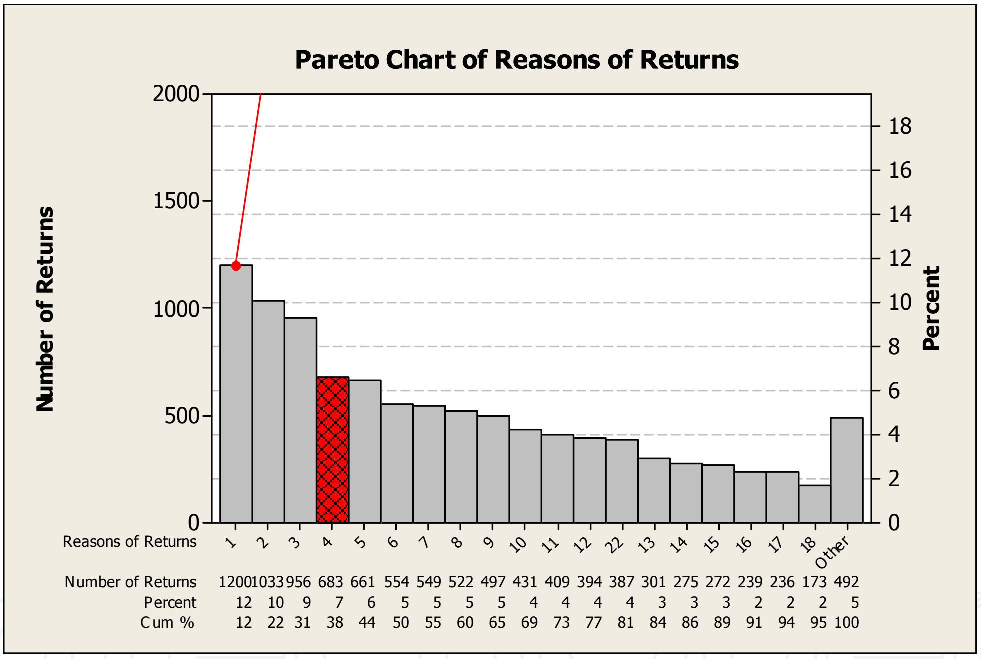

Figure 3. Pareto chart of Returns

Slippage of mirror nightstand is a reason of customer dissatisfaction. The aim is to increase customer satisfaction by reducing variance and maximizing mirror slippage time. After problem definition and forming a team, the next step is to perform a detailed process analysis. A process chart was constructed by the team and is given in Figure 4.

Figure 4. Process chart

2.2. Measure

Key input variables (factors) and their levels are defined to determine impacts of variables on process performance. The steps which will be followed in this phase are:

- Identifying key quality characteristics (dependent and independent variables),
- Measuring system capability,
- Finding a solution to data collection.

In measure phase, most important factors and levels were defined clearly for the slippage problem. The number of independent variables (or factors) were found as 13 and given in Table 1. 13 factors which are affected glass-mirror slippage were decided by brainstorming of team members and it was decided to evaluate all factors as two levels.

Control Factors	Factor Effects	Min. Level (-1)	Max. Level (+1)
Environment temperature (C^o)	A	- 20	60
Surface Cleanliness	B	Dirty	Clean
Temperature Difference in working place (C^o)	C	14	28
Storage Position	D	Bottom	Top
Mirror Cleanliness	E	Dirty	Clean
Waiting time (hours)	F	0	2
Anti slip tape quality	G	ELSEM*	TESA*
Styrofoam	H	Nonexistence	Existence
Cleaning liquid	J	Existence	Nonexistence
Dust in the working place	K	Dirty	Clean
Double sided anti slip tape quality	L	Existence	Nonexistence
Anti slip tape usage	M	Undismantle	Dismantle
Anti slip tape usage rate (centimeter)	N	6	12
*ELSEM and TESA are the names of anti-slip tapes			

Table 1. List of experimental control factor

2.3. Analyse

Which tools will be used is defined and factor analyzes are done by using some statistical methods. The steps which will be followed in this phase are:

- Identifying causes of defects and variation,
- Conducting multi-variable analysis,
- Collecting process data about dependent and independent variables,
- Using regression analysis to define relationship between dependent and independent variables.

Exp. Number	A (Co)	B	C (Co)	D	E	F (hours)	G	H	J	K	L	M	N (cm)	Slippage (hours)
1	60 (1)	Clean (1)	14 (-1)	Bottom (-1)	Clean (1)	2 (1)	Tesa (1)	Existence (1)	Existence (-1)	Dirty (-1)	Existence (-1)	Undismantle (-1)	12 (1)	No slippage
2	-20 (-1)	Clean (1)	28 (1)	Top (1)	Dirty (-1)	2 (1)	Elsem (-1)	Existence (1)	Nonexistence (1)	Dirty (-1)	Existence (-1)	Undismantle (-1)	6 (-1)	No slippage
3	60 (1)	Dirty (-1)	28 (1)	Bottom (-1)	Clean (1)	2 (1)	Elsem (-1)	Existence (1)	Nonexistence (1)	Dirty (-1)	Nonexistence (1)	Dismantle (1)	12 (1)	16
4	-20 (-1)	Dirty (-1)	28 (1)	Top (1)	Dirty (-1)	0 (-1)	Tesa (1)	Nonexistence (-1)	Existence (-1)	Dirty (-1)	Nonexistence (1)	Dismantle (1)	12 (1)	No slippage
5	-20 (-1)	Clean (1)	14 (-1)	Bottom (-1)	Dirty (-1)	2 (1)	Elsem (-1)	Nonexistence (-1)	Nonexistence (1)	Clean (1)	Nonexistence (1)	Undismantle (-1)	12 (1)	No slippage
6	-20 (-1)	Clean (1)	28 (1)	Top (1)	Clean (1)	0 (-1)	Tesa (1)	Existence (1)	Existence (-1)	Clean (1)	Nonexistence (1)	Undismantle (-1)	12 (1)	No slippage
7	-20 (-1)	Dirty (-1)	14 (-1)	Top (1)	Dirty (-1)	2 (1)	Tesa (1)	Existence (1)	Nonexistence (1)	Dirty (-1)	Existence (-1)	Dismantle (1)	6 (-1)	No slippage
8	-20 (-1)	Clean (1)	28 (1)	Bottom (-1)	Clean (1)	2 (1)	Tesa (1)	Nonexistence (-1)	Nonexistence (1)	Clean (1)	Nonexistence (1)	Dismantle (1)	6 (-1)	No slippage
9	60 (1)	Clean (1)	14 (-1)	Top (1)	Dirty (-1)	2 (1)	Tesa (1)	Nonexistence (-1)	Nonexistence (1)	Clean (1)	Existence (-1)	Dismantle (1)	12 (1)	No slippage
10	-20 (-1)	Clean (1)	14 (-1)	Bottom (-1)	Clean (1)	0 (-1)	Tesa (1)	Nonexistence (-1)	Existence (-1)	Dirty (-1)	Nonexistence (1)	Dismantle (1)	6 (-1)	No slippage
11	-20 (-1)	Clean (1)	28 (1)	Top (1)	Clean (1)	2 (1)	Elsem (-1)	Nonexistence (-1)	Existence (-1)	Clean (1)	Existence (-1)	Undismantle (-1)	6 (-1)	No slippage
12	-20 (-1)	Dirty (-1)	28 (1)	Bottom (-1)	Dirty (-1)	2 (1)	Elsem (-1)	Existence (1)	Existence (-1)	Clean (1)	Existence (-1)	Dismantle (1)	12 (1)	No slippage
13	60 (1)	Dirty (-1)	28 (1)	Top (1)	Clean (1)	0 (-1)	Tesa (1)	Nonexistence (-1)	Nonexistence (1)	Dirty (-1)	Existence (-1)	Undismantle (-1)	12 (1)	No slippage
14	-20 (-1)	Dirty (-1)	14 (-1)	Top (1)	Clean (1)	0 (-1)	Tesa (1)	Existence (1)	Nonexistence (1)	Clean (1)	Existence (-1)	Undismantle (-1)	6 (-1)	No slippage
15	60 (1)	Dirty (-1)	14 (-1)	Bottom (-1)	Clean (1)	0 (-1)	Elsem (-1)	Existence (1)	Existence (-1)	Clean (1)	Existence (-1)	Dismantle (1)	6 (-1)	2-3
16	60 (1)	Dirty (-1)	28 (1)	Top (1)	Dirty (-1)	2 (1)	Tesa (1)	Existence (1)	Existence (-1)	Clean (1)	Nonexistence (1)	Dismantle (1)	6 (-1)	No slippage
17	60 (1)	Clean (1)	28 (1)	Bottom (-1)	Dirty (-1)	0 (-1)	Tesa (1)	Nonexistence (-1)	Nonexistence (1)	Dirty (-1)	Existence (-1)	Dismantle (1)	6 (-1)	72
18	60 (1)	Clean (1)	14 (-1)	Top (1)	Clean (1)	2 (1)	Elsem (-1)	Nonexistence (-1)	Existence (-1)	Dirty (-1)	Existence (-1)	Dismantle (1)	12 (1)	16
19	60 (1)	Dirty (-1)	14 (-1)	Bottom (-1)	Dirty (-1)	2 (1)	Tesa (1)	Nonexistence (-1)	Existence (-1)	Clean (1)	Nonexistence (1)	Undismantle (-1)	6 (-1)	72
20	60 (1)	Dirty (-1)	14 (-1)	Top (1)	Dirty (-1)	0 (-1)	Elsem (-1)	Nonexistence (-1)	Nonexistence (1)	Clean (1)	Nonexistence (1)	Undismantle (-1)	12 (1)	2-3
21	-20 (-1)	Dirty (-1)	28 (1)	Bottom (-1)	Clean (1)	0 (-1)	Elsem (-1)	Nonexistence (-1)	Nonexistence (1)	Clean (1)	Existence (-1)	Dismantle (1)	12 (1)	No slippage
22	60 (1)	Clean (1)	28 (1)	Bottom (-1)	Dirty (-1)	0 (-1)	Elsem (-1)	Existence (1)	Nonexistence (1)	Dirty (-1)	Nonexistence (1)	Undismantle (-1)	6 (-1)	2-3
23	60 (1)	Clean (1)	28 (1)	Bottom (-1)	Dirty (-1)	0 (-1)	Tesa (1)	Existence (1)	Existence (-1)	Clean (1)	Existence (-1)	Undismantle (-1)	12 (1)	No slippage
24	-20 (-1)	Dirty (-1)	14 (-1)	Bottom (-1)	Clean (1)	2 (1)	Tesa (1)	Existence (1)	Nonexistence (1)	Dirty (-1)	Nonexistence (1)	Undismantle (-1)	12 (1)	No slippage
25	60 (1)	Clean (1)	14 (-1)	Top (1)	Clean (1)	0 (-1)	Elsem (-1)	Existence (1)	Nonexistence (1)	Clean (1)	Nonexistence (1)	Dismantle (1)	6 (-1)	2-3
26	-20 (-1)	Dirty (-1)	14 (-1)	Bottom (-1)	Dirty (-1)	0 (-1)	Elsem (-1)	Nonexistence (-1)	Existence (-1)	Dirty (-1)	Existence (-1)	Undismantle (-1)	6 (-1)	No slippage
27	60 (1)	Dirty (-1)	28 (1)	Top (1)	Clean (1)	2 (1)	Elsem (-1)	Nonexistence (-1)	Existence (-1)	Dirty (-1)	Nonexistence (1)	Undismantle (-1)	6 (-1)	16
28	-20 (-1)	Clean (1)	14 (-1)	Top (1)	Dirty (-1)	0 (-1)	Elsem (-1)	Existence (1)	Existence (-1)	Dirty (-1)	Nonexistence (1)	Dismantle (1)	12 (1)	No slippage

Table 2. Orthogonal Matrix of PB design

In this phase, we need to collect data about process variables to find the resource of variation in the system. By this way, an experimental design will be performed. If a full factorial experimental design is run, we need 2^{13} (8192) experiment for trying all possibilities. This condition takes too much time and effort. On the other hand, a Plackett Burman fractional factorial design can give faster results in a short time. For this reason, application of fractional factorial experimental design was decided and by considering all the advantages above, Placket-Burman L_{28} experimental design was used in this study. Orthogonal (Design) matrix is given in Table 2.

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	***1***	***11100,2***	***11100,2***	***11100,2***	***35,12***	***0,000***
B	1	110,0	110,0	110,0	0,35	0,565
C	1	279,7	279,7	279,7	0,89	0,363
D	1	118,1	118,1	118,1	0,37	0,551
E	1	885,9	885,9	885,9	2,80	0,116
F	1	390,0	390,0	390,0	1,23	0,285
G	***1***	***8349,0***	***8349,0***	***8349,0***	***26,42***	***0,000***
H	1	325,7	325,7	325,7	1,03	0,327
J	1	299,0	299,0	299,0	0,95	0,347
K	1	18,1	18,1	18,1	0,06	0,814
L	1	1627,9	1627,9	1627,9	5,15	0,040
M	1	157,9	157,9	157,9	0,50	0,491
N	1	192,9	192,9	192,9	0,61	0,448
Error	14	4424,6	4424,6	316,0		
Total	27	28279,2				

Table 3. ANOVA for factors

ANOVA was performed to verify whether the main effects exist or not between variables and given in Table 3. Confidence level of the model was selected as 99 %. Main effects plotted for mean response is as shown in Figure 5.

2.4. Plackett-burman in screening design

This design is used for screening a large number of process factors to identify the most important parameters that have a significant impact on the process performance. It provides a reduction in the number of factors that needed to be observed. PB design includes in a family of screening design. The natures of interactions among the factors are not interested in screening designs. Geometric PB designs contain M number of experiment which is a power of two (4, 8, 16…etc.). On the other hand, non-geometric designs contain M number of experiment which are multiples of four but not power of two (12, 20, 24, 28…etc.)[2]. All main effects have same precision in PB designs.

After defining the key parameters, if necessary, full factorial, fractional factorial designs and response surface method, subsequent experiments can be run. Full factorial design needs all possible combinations of levels for all factors. PB designs which focus on the main effects by

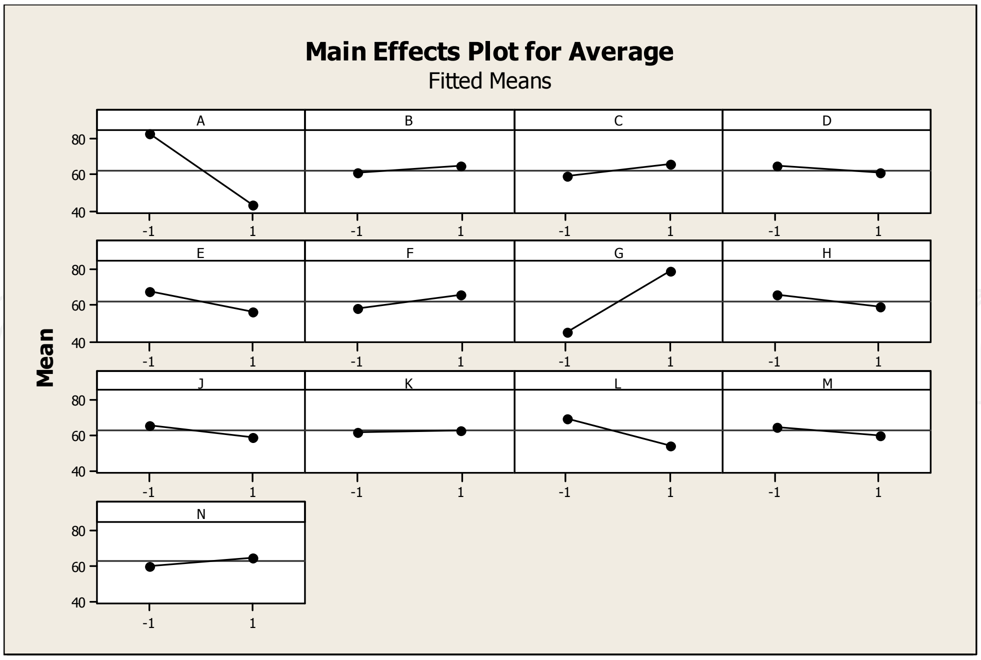

Figure 5. Main effects plot for average

considering the interactions among the factors are negligible[14]. It can be applied effectively to industrial studies which need to analyze many factors in the same manner[15]. The main aim is not to see interactions among the factors, but this doesn't mean that we couldn't have any idea about the interactions among factors. It is proved that, PB can be used even two sided interactions and main effects are confounded[16]. In PB designs, M+1 experiment are conducting to analyze M factors and generally it is advised to use for main effects.

The 12, 20, 24, 28- run PB designs have a special importance, because they fill the gap in the standard design. On the other hand, these designs have a high alias structure. If it is assumed that there are no interactions between the factors, this alias structure can be prevented. But this assumption is not possible in real life systems. To get away with alias structures, it is provided to make a second run, but not an exact replication[17]. In a research, it is proved that using 28-run PB gives best results for a system between 32-run design fractional factorial, 28 experiment design PB and 28 experiment design a random balance[18].

2.5. Improve

Improvement points which yield an optimum process are selected and system model is constructed by considering the optimum condition. The steps which will be followed in this phase are:

- Conducting design of experiments.
- Trying to improve process by eliminating variation.
- Optimizing process.

Slippage time of mirror was analyzed by using Plackett-Burman experimental design matrix. After the experiments were conducted, some statistical analyses were done to define parameters which have a great variance. Also, two way interactions were taken into consideration. An optimum setting which contains different factor levels was found. This provides maximum slippage time and extracted data was used in the real manufacturing of mirror nightstand.

Our main goal in this study is decreasing process variability by defining most effective factors and levels on quality characteristics. PB experimental design module of MINITAB 15.0 software was used. As a result, optimal factor setting obtained is -1,1,1,1,-1,1,1,1,-1,1,-1,-1,1 (Environmental Temperature= -20 C^o; surface cleanliness = clean, temperature difference (C^o) in working place = 28 C^o; storage position= top; mirror cleanliness= dirty; waiting time= 2 hours; anti slip tape quality= Tesa; styrofoam= existence; cleaning liquid= existence; dust in the working place = clean; double-sided tape usage = existence; anti slip tape usage= undismantle; anti slip tape usage rate= 12cm). If these conditions are applied to process/product, a quality product having a new design reducing complaint of customers comes out and mirror nightstand slippage will not occur.

Factors	Effect Values	Coef.	Interaction	Effect Values	Coef.
Fixed values		56,82	Fixed Values		56,82
A	***-32,36***	***-16,18***	A*B	1,48	0.74
B	1,48	0,74	A*C	3,48	1,74
C	3,48	1,74	A*D	-1,26	-0,63
D	-1,26	-0,63	A*E	2,40	1,20
E	2,40	1,20	A*F	2,07	1,04
F	2,07	1,04	***A*G***	***31,62***	***15,81***
G	***31,62***	***15,81***	A*H	-3,05	-1,52
H	-3,05	-1,52	A*J	-1,71	-0,86
J	-1,71	-0,86	A*K	1,00	0,50
K	1,00	0,50	A*L	1,50	0,75
L	1,50	0,75	A*M	1,33	0,67
M	1,33	0,67	A*N	2,17	1,08
N	2,17	1,08	B*C	-0,00	-0,00
			B*D	-0,00	-0,00

Table 4. Factors and interaction table

When Table 4 is analyzed, A, G factors and their interaction values have a significant difference from others. In order to decide which effects are statistically meaningful, normal plot of standardized effects was used. While interpreting the normal plot of standardized effects, important factors can be shown under the plot and left of the line, or above the plot and right of the line. As shown in the Figure 6, A (Environment temperature), G (Anti slip tape quality) and A-G interaction are significant factors for this study. While optimizing dependent variable, these factors must be considered together.

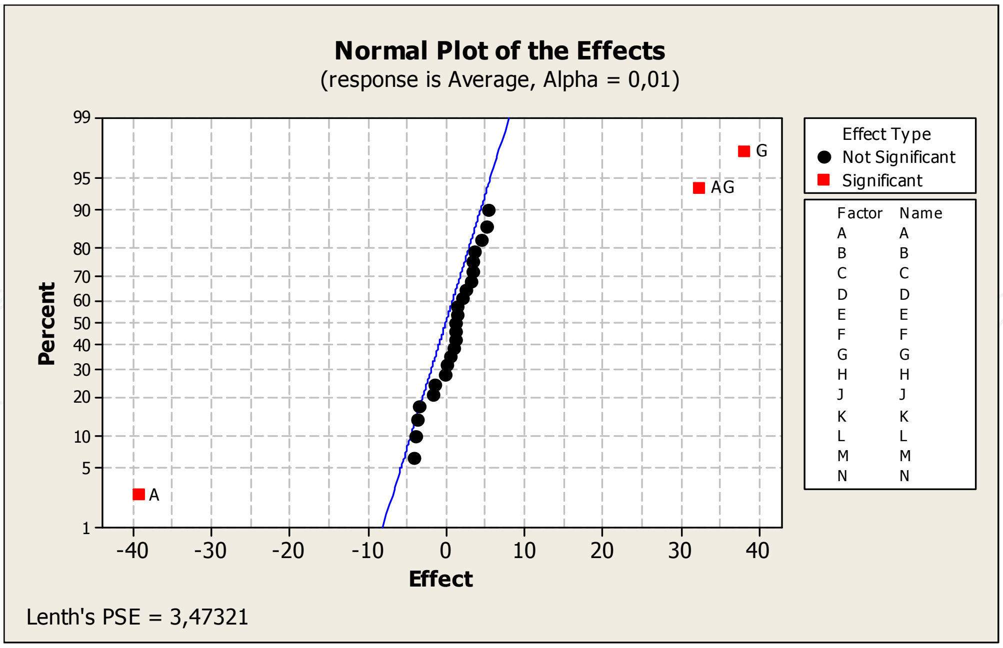

Figure 6. Normal plot of standardized effects

We can also see the importance of A and G factors from pareto chart of standardized effects as shown in Figure 7.

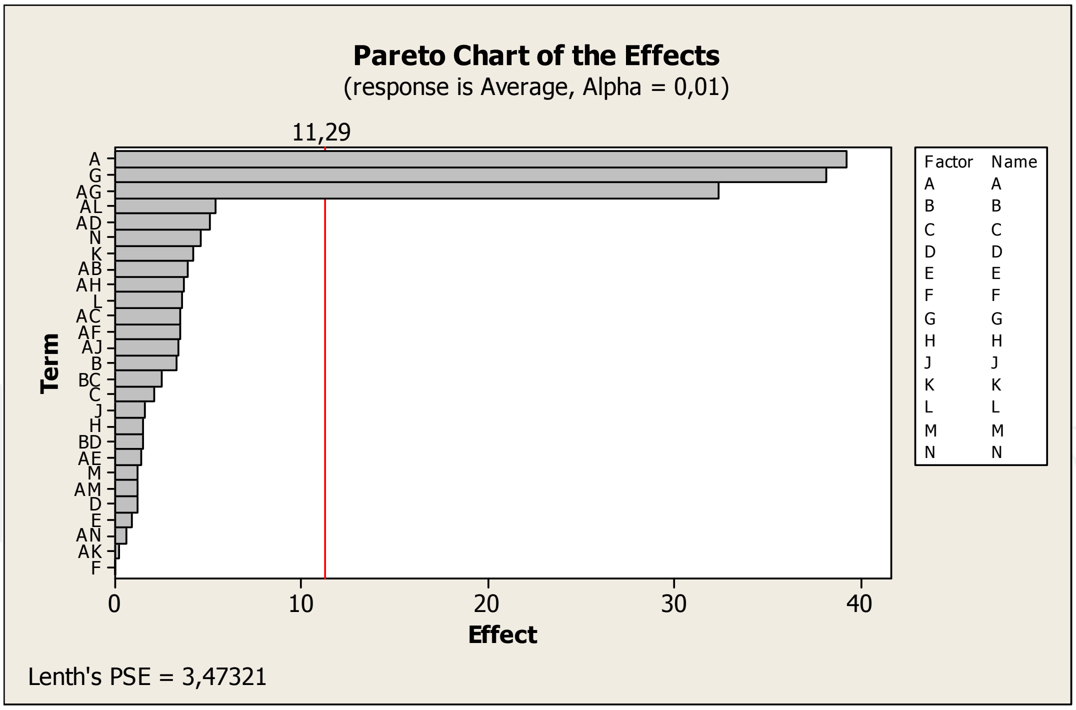

Figure 7. Pareto chart of effects

2.6. Control

New responsibility distribution is done as a result of optimization, and data is collected to achieve continuous improvement[2]. The steps which will be followed in this phase are:

- Checking new system performance,
- Monitoring improvements,
- Implementing control plans and trying to construct continuous improvements in the system.

In order to test the model verification regarding whether this design gives optimal result or not, optimal factor setting was applied in the process and process data of 6 months were collected. We realized that Product-complaints were reduced by 60 %.

3. Application of ANN (Artificial Neural Network)

ANN can perform modeling in nonlinear systems as well as linear systems. Nonlinear relations between data are extracted by ANN which is inspired with human nervous system. In a neural network, three have been three types of units: input units which receive data from outside, output units which send data out of the neural network, and hidden units where the signals are transferred inside of the neuron. Weights can be represented as the strength of the connection between an input and a neuron. The neuron can be defined as processing units, the place where actual activity occurs. An activation function controls the value of the input while transferring it from the layers, until it reaches to output. Each neuron receives input from neighbours and use these inputs while computing an output signal[20]. When this data flow occurs between the units, weights are adjusted. There can be different types of ANN. Multilayer Perceptron (MLP) and Radial Basis Function are the most known types of ANN. MLP networks consist of typically an input layer, single or more hidden layers, and one output layer. Hidden layers have one or more hidden neurons which perform nonlinear mapping between inputs and outputs[21]. Relationship between input and output is constructed by using some methods that is needed for adjusting the weights during the training session. This can be represent as learning algorithm. Choosing the proper learning algorithm is also very important while training the networks. The most common learning algorithm is called Back Propagation (BP). There are several types of optimization techniques for ANN using the backpropagation algorithm such as gradient descent method, gradient descent with momentum, conjugate gradient method (Fletcher-Reeves, Polak-Ribiere), quasi-newton method (Broyden-Fletcher-Goldfarb-Shanno - BFGS). Generally, levenberg-marquardt method is used for the networks which contain up to a few hundred weights, converges faster and uses second derivatives for solutions. For the moderate size networks, quasi-newton method are often the next fastest algorithms[22]. BFGS is the most successful quasi-newton method employed in our study[23].

The optimal number of nodes in the hidden layer is generally computed by a trial-and-error approach[24]. To find the best neural network, networks which contain different number of hidden neurons are compared with each other[25]. Mean square error (MSE) is the basic criteria while judging the capability of networks. If we use too much hidden neurons, this leads us too much flexibility and over fitting. On the other hand, if we use too few hidden neurons, this prevents the learning capability[26]. Therefore, one of the biggest problems is to find the proper number of hidden neurons. Furthermore, the simplest architecture is better than others[27]. Thus, single hidden layer can be chosen and it is sufficient for many continuous nonlinear mapping.

In this study, after the design of experiment study was conducted, ANN application was done for modeling the system. PB experiment data were used as input to ANN. To prevent alias structure of PB, a second run was used as input; but not an exact replication. Data were divided into two parts as training (80%), and testing (20%), respectively. The Neural Network module of STATISTICA 9.0 software was employed in modeling the ANN. In the network, there were 13 inputs and one output as defined before. A trial and error method was used in deciding the best model for the system. 500 different combinations of activation functions and neuron numbers were tried by considering the fitted model MSE. The performance of best five models was evaluated and MLP 13-5-1 model was chosen as shown in Table 5. The MAE and MSE of the selected topology are 2.957247 and 15.54706, respectively. Generally, using the sigmoid (logistic) function in ANN topology provides a good nonlinear input–output mapping capability[28]. A weight decay method was used to reduce the overfitting problem. This option encourages the development of smaller weights, so it potentially improves performance of the network and modifies the network's error function to penalize large weights[29].

Network Architecture	Training perf.	Test perf.	Training error	Test error	Training algorithm	Hidden activation function	Output activation function
MLP 13-7-1	0.986217	0.988856	21.77105	8.85785	BFGS	Exponential	Logistic
MLP 13-11-1	0.986836	0.989038	20.68673	10.50230	BFGS	Exponential	Logistic
MLP 13-9-1	0.980550	0.987936	23.20724	11.52654	BFGS	Exponential	Logistic
MLP 13-10-1	0.984314	0.986702	18.20639	12.64308	BFGS	Exponential	Logistic
MLP 13-5-1	***0.986941***	***0.990763***	***23.59058***	***7.77353***	***BFGS***	***Exponential***	***Logistic***

Table 5. Best Network Architecture

ANN model was controlled whether the slippage occurs or not for PB's optimal set. We showed that slippage time was predicted as 89 hours in the ANN. We wanted to see which parameters are significant for ANN as in PB. On account of this, sensitivity analysis was performed in ANN. There have been some researches about determining the effects of the input parameters on the response variable[30] in terms of sensitivity. Sensitivity analyzes can be applied to a network after the training session is completed. It tries to see what the effect would be of changing the inputs of the model on the overall model fit. While an input of the artificial neural network model is eliminated from the model, sums of squares residuals for the model are analyzed and the inputs can be sorted by their importance[29]. The larger the variance in the error after the parameter is omitted, the more important the variable is[31]. As a result of the sensitivity analysis, it proves that A and G are really the most important parameters for the ANN model. This sensitivity analysis values were normalized as given in Figure 8.

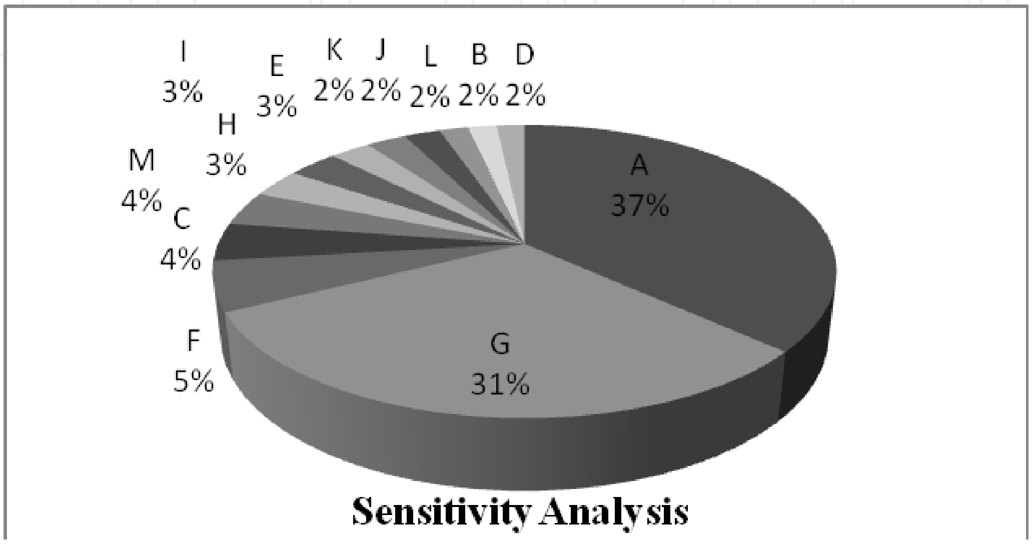

Figure 8. Pie chart of normalized sensitivity analysis

4. Conclusion

In this study, PB experimental design method was used from the point of view of Six Sigma philosophy. Besides, ANN was employed for the solution of same problem and results were compared whether nightstand mirror slippage occurs or not. If the mirror of nightstand can stand out against rotate without slipping as long as 72 hours, it is called as 'no slippage'. In this context, the modeling of PB and ANN came to conclusion as 'no slippage'. This is the first time we used PB and ANN in the literature for a furniture manufacturing firm.

We defined significant factors with ANOVA used for PB and sensitivity analysis of ANN was performed for verification. Environment temperature, anti slip tape quality and their interactions were the significant factors for both modeling. Customer complaints were decreased by 60 % in products / processes with real production of optimal factor settings. Thus, we found applicability of PB and ANN for nightstand mirror slippage problem. In the future, optimum solutions can be compared by using different meta- heuristics such as Genetic algorithm, Particle swarm optimization and Bees Algorithm.

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Chapter 6

Redesigning the Service Process for Total Quality in Government Hospitals: Evidence from Kwara State

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Additional information is available at the end of the chapter

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1. Introduction

Total Quality Management (TQM) application in Public Health sector is recent and it has begun to redefine the administrative infrastructure and mindset of managers in different fronts. The old management models in public sector that hardly differentiate between management and leaderships are now beginning to change through identification and focus on meeting and exceeding the needs of customers (citizens). The application of TQM tools and techniques has begun to re-orientate managers and policy makers' arbitrary command and control methodology with strong emphasis being placed on leadership, teamwork and continuous learning. The old culture of top-down management where the subordinates must wait endlessly for their superiors before they can perform has impinged the implementation of TQM in government hospitals.

Research has found that 4 percent of hospital patients suffer an avoidable injury, 7 percent experience medication error, and 45 percent experience some medical mismanagement *(Andrew et al 1977).* In a recent study conducted by *Lagasse et al* (1995), 8 percent anesthetics error were found to be due to human error and 92 percent due to system error.

Health care organizations therefore can use service process redesign to minimize the system error. The quality of service delivered is contingent on the service process that is put in place in organizations. Service process has been therefore identified as the core of service delivery, not only frequently visible to customers (patients), but often constituting the very service itself (Johnston and Clerk, 2000). Unfortunately, many private organizations and public outfits devote little attention to understanding and designing this very aspect of their businesses.

Once the service process is erroneously designed, it has a way of affecting the quality of service delivered to the patients of government hospitals.

Health care redesign can be broadly defined as thinking through from scratch, the best process to achieve speedy and effective care from a patient perspective, identifying where delays, unnecessary steps or potential error are built in the process and then redesign the process to remove them and dramatically improve the quality of care (Locock, 2003). Service process redesign therefore is used to tackle variation in the quality of care and improve patients' satisfaction. Service process redesign is therefore a radical challenge to traditional assumptions and practices which involves thinking through the best process to achieve speedy and effective patients' care.

Redesigning the service process in an organization therefore involves assessing how the current functions, structures and responsibilities are operating and identifying what would be done to improve the efficiency and effectiveness of operation within the unit.

Ching chow (2003) conducted a survey for a hospital to identify the major obstacles to TQM implementation in health care industry as;

a. Organizational structure: Traditionally, the health care organizations use functional-hierarchical structure as the base which may cause poor communication between sections.
b. Leadership style: Most leaders of health care organizations are specialists in their profession with authority. Hence, the unchallengeable leadership style does not allow health care professionals to accept the opinions of their subordinates.
c. Organizational culture: The health care organizational structure and leadership style create a highly hierarchical, bureaucratic and authoritarian culture which conflict with the idea of empowerment of subordinates.
d. Professional autonomy: The physicians, medical technicians, and clinical professionals work independently in their fields which makes the issue of teamwork (which is the basis of TQM), impossible. Different departments might have different views on TQM.
e. Lack of Consensus: Misunderstanding might ensue between the physicians with respect to application of TQM. While TQM practices may be considered as significant for administrative efficiency and service quality, it cannot be applied for medical treatment. This explains why health care professionals do not have strong enthusiasm for its adoption.
f. Internal requirement domination: The health care organizations tend to focus on their internal requirement for medical treatment rather than the patients' needs. The ethics of the profession are strictly followed. The emergency situation of a patient into the hospital will not make a physician to violate the process of diagnosis.
g. Efficiency-oriented: Efficiency is the hallmark of medical profession and not how much income they would make from surgeries and chemical treatments. The objective is qualitative performance. Hence, such bias tends to affect their understanding of patients' conditions and improper judgment resulting in poor quality.

h. Manpower shortfall: Insufficient manpower in hospitals means that professional specialists are overloaded in their work. Since the physicians are much more involved in their routine work, participating in TQM implementation is considered as an added responsibility that they may not have time for.

The objective of this paper therefore is to investigate how redesigning of the service process can engender total quality in Kwara state government hospitals as well as removing barriers to TQM implementation.

2. Problem statement

The implementation of Total Quality Management in Kwara State Hospitals is fraught with some difficulties. These difficulties have made the attainment of quality goals by the government elusive. TQM has been described as a co-operative form of doing business which relies on the talent and capabilities of both labour and management to improve quality and productivity continually using teams (Plek 1995). This definition has three ingredients necessary for TQM to flourish in any service organization. They are:

i. Participative Management
ii. Continuous Process improvement and
iii. The use of Teams.

Redesigning the hospital process falls under the second ingredient. Hence, successful TQM implementation is dependent on employee participation, employee training, technology, employee-patients' relationship, drug administration, employee motivation and care takers.

The findings and pricing, supervision conformity to standard and feedback from patients are other factors that infringed the hospital process. This study sees redesigning of the hospital process as a leeway to checkmate the poor quality service of the hospitals with the intent of satisfying the patients of the hospitals.

3. Methodology

There are sixteen government hospitals in Kwara state which constitute the population. But for the sake of the study, 4 specialist hospitals in Ifelodun, Ilorin East, Moro and Offa are the sampled hospitals for this study. This is because these four specialist hospitals constitute the referral centres for General Hospitals and Community health centres that exist in the state.

50 copies of questionnaire were served to 50 patients per sampled hospitals. A Likert scale of 5 points was used to measure the level of agreement and disagreement by the respondents. The response format is as follows:

SA – Strongly Agree
A – Agree

N – Not sure
D – Disagree
SD – Strongly Disagree

Frequency Distribution was used to analyze the data collected and to examine the pattern of response to each variable under investigation.

4. Data analysis

Since the study seeks to investigate how redesigning the service process can engender quality service in Government hospitals which will consequently affect the patients' satisfaction, the frequency counts were used to capture the responses of the respondents. From the gender distribution of respondents below

Specialists Hospitals	Male	Female	Total
Ifelodun	18	32	50
Ilorin East	21	29	50
Moro	22	28	50
Offa	26	24	50
Total	**87**	**113**	**200**

Source: Administered questionnaire 2012

Table 1. Gender distribution of respondents

From the table above, 43.5% of the respondents were males while 56.5% were females. In other words, across the four local governments where the specialist hospitals were, there were more female patients than males. This is actually evident from the table as it was only in Offa specialist hospital that we had more male patients than females. This trend of female patients' dominance except in Offa LGA may not be unconnected with gynecological related sicknesses. The eagerness of the patients to fill the questionnaire was a sign of service dissatisfaction which in turn suggests the need for redesign of the service process.

Age classification	Frequency (n)	Percentage (%)
21-30 years	40	20.0
31-40 years	30	15.0
41-50 years	92	46.0
51-60 years	15	7.5
61 and above	23	11.5
Total	**200**	**100.0**

Source: Administered questionnaire 2012

Table 2. Respondents' age-range

From the respondents' age classification above, 46.0% of the respondents were within the age of 41-50 years while 20% of the respondents fall within the age range of 21-30 years. The reason for the high rate of patients within the 41-50 years category may not be unconnected with the Menopausal issues since the respondents are female-dominated. 81% of the respondents were between the age of 21 and 50 years which is an indication of level of literacy of the respondents. In other words, they seem to understand the process of service quality and could say categorically whether they are satisfied or not.

Marital status	Frequency	Percentage (%)
Single	50	25.0
Married	100	50.0
Widowed	20	10.0
Divorce	30	15.0
Total	**200**	**100.0**

Table 3. Respondents' marital status

With reference to the above table, 25% were singles, 50% married, 15% divorcee & 10% widows and widowers.

Process infringements	Frequency	Percentage (%)
Employees participation	18	9.0
Employees Training	20	10.0
Technology	14	7.0
Employee-patients' relationship	25	12.5
Drug administration	16	8.0
Employees motivation	20	10.0
Care-takers	26	13.0
Language barriers	12	6.0
Funding and pricing	14	7.0
Supervision	10	5.0
Conformity to standards	15	7.5
Feedback from patients	10	5.0
Total	**200**	**100.0**

Source: Administrated Questionnaire 2012

Table 4. Distribution of Respondents on service process infringements

Four process infringement factors featured prominently in the respondents' responses to service process infringements. They are caretakers, employee-patients' relationship, employees' training and employees' motivation. The care-takers i.e., those who stay with the patients in the hospital constitute 13% of the process infringements which in-turn, impact negatively on the quality of services in the specialist hospitals. This is followed by employee-patients' relationship. This may be referred to as the interpersonal factors that boarder on Professional-patients' relationships. Employee training and employee motivation can also affect the quality of service where they are not available.

Process infringement factors	Percentage (%)	Ranking
Care-takers	13.0	1
Employee-patients' relationship	12.5	2
Employees' training	10.0	3
Employees' motivation	10.0	3
Employees' participation	9.0	5
Drug administration	8.0	6
Conformity to standards	7.5	7
Technology	7.0	8
Funding & pricing	7.0	8
Language barriers	6.0	10
Supervision	5.0	11
Feedback from patients	5.0	11
Total	**100**	

Table 5. Ranking of process infringement factors

Methods	Frequency	Percentage (%)
Detection	20	10
Process mapping	50	25
Statistical process control	60	30
Failsafing	70	35
Total	**200**	**100**

Source: Questionnaire Administered 2012

Table 6. Distribution of respondents on methods of overcoming the process infringement factors

From the data on table 6, 70 respondents favoured 'failsafing' which is a simple but effective technique to reduce the likelihood of process failure and ensure that both employees and patients do the right thing. The 70 respondents accounted for 35% solution to process infringements. 30% of the process infringements can be overcome with statistical control.

5. Hypothesis testing

The only hypothesis tested in this study is to find out whether redesigning the service process has a way of enhancing total quality in Kwara state specialist hospitals.

Ho: Redesigning the service process does not affect quality of services in government hospitals.

H1: Redesigning the service process significantly affect the quality of service.

Options	**SA**	**A**	**N**	**D**	**SD**	**Total**
Yes	110	12	3	10	6	141
No	20	15	5	11	8	59
Total	**130**	**27**	**8**	**21**	**14**	**200**

Table 7. Distribution of respondents on redesign of the service process for quality service

Table 7 is the observed value of respondents of service process redesign and quality service. To obtain the expected value, we simply use the formulae

Fe=Row total x Column total/Grand total

fo	**fe**	**(fo-fe)**	**(fo-fe)2/fe**
110	91.65	336.72	3.67
12	19.04	49.56	2.60
3	5.64	6.96	1.23
10	14.8	21.12	1.42
6	9.87	14.98	1.51
20	13.4	338.56	8.82
15	7.96	49.56	6.22
5	2.36	6.96	2.95
11	6.19	23.14	3.74
8	4.13	14.97	3.62
		Total X2 =	**35.8**

Table 8. Frequency of service process redesign on quality

From the table 8 above, the X2 calculated is 35.78 while the X2-tabulated at 5% significance level and at (2-1) (5-1) = 4 degree of freedom i.e. 14.9. Since X2 calculated is greater than X2 tabulated, we reject the null hypothesis that says redesigning the service process does not affect the quality of service and accept the alternative hypothesis that says redesigning the service process significantly affect the quality of service rendered by hospitals.

From the hypothesis tested, redesigning the service process has a way of affecting the quality of service as well as patients' satisfaction.

6. Recommendations

As we have rightly observed in the literature review, all stakeholders in health care have a role to play in ensuring that the process infringements are checkmated and minimized.

The following recommendations are important for the improvement of the service process:

i. The dichotomy between doctors and nurses in terms of professionalism which make certain area of Medicare a 'no go area' for nurses must be checked, so that when doctors are not available, the nurses can to a certain extent come in to save the life of the patients.
ii. Employees' training and refresher courses are very important to sensitize the workers on latest technological evolution.
iii. Employees-patients relationship must be cordial because whatever injury suffered by the patient has a way of affecting the hospitals.
iv. Care-takers that will stay with the patients must be educated such that a wrong administration of drug is not given. Alternatively, the hospital employees particularly the nurses should be charged with the responsibility of administering the drugs.
v. Where language barrier is to infringe the service process, an interpreter may be immediately hired to serve as a stop-gap for wrong diagnosis.
vi. Government should appoint supervisors or agency who will not compromise quality for material gain. Those supervisors and agencies can interact with the patients to know what their misgivings are.
vii. The agency in (IV) above should create a way through which those whom have been discharged from the hospital will give a feedback to the hospitals.
viii. Government as a matter of policy should develop a motivational formulae that will serve as an impetus for greater and efficient service.
ix. Government should release funds for the management of hospitals

7. Conclusion

This paper is of the opinion that what we refer to as infringement factors to the service process in developing nations like Nigeria may not actually be the infringement factors in developed nations. Hence, this study would provoke further investigations into the service process infringements in developed world. If patients' satisfaction is the basis for establishing specialist hospitals, anything that will make that objective unrealizable must be removed. This exactly is what service process redesign intends to achieve.

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